# NATIONAL COOPERATIVE SOIL SURVEY

# Western Regional Conference Proceedings

# Kahului, Maui, Hawaii June 13-17, 1988

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## PROCEEDINGS

of the

## WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE

June 13-17, 1988



MauiCommunity College Kahului, Maui

## WESTERN REGIONAL SOIL SURVEY WORK PLANNING CONFERENCE Kahului, Maui, Hawaii June 12-17, 1988

#### Theme--"Working toward asrotechnology transfer"

SUNDAY, JUNE 12, 1988--MAUI BEACH HOTEL (Lobby)

2:00-4:00 p.m. Registration

MONDAY, JUNE 13, 1988--MAUI COMMUNITY COLLEGE (Lecture Hall 10A)

7:30 a.m. Registration

8:00 a.m. Introduction and announcements

Presiding: H. H. Sato

- 8:15 a.m. Welcome and opening comments
  --Noel P. Kefford, Dean, College of Tropical
  Agriculture and Human Resources, University of
  Hawaii, Honolulu
- 8:30 a.m. Welcome and opening comments
  --Richard N. Duncan, State Conservationist, SCS,
  USDA, Honolulu
- 8:45 a.m. The Future of The National Cooperative Soil Survey --Francis C. H. Lum, Assistant Chief, SCS, USDA, Wash., D. C.
- 9:15 a.m. Farm Security Act--Problem and Opportunities
  --James Carley, State Soil Scientist, SCS, USDA,
  Spokane
- 10:00 a.m. (break)
- 10:45 a.m. Role of National Headquarters Under New Realignment --Richard W. Arnold, Director, Soil Survey Div., SCS, USDA, Wash, D. C.
- 11:05 a.m. Role of National Soil Survey Center
  --Rodney F. Harner, National Leader, Soil
  Classification and Mapping, SCS, USDA, Lincoln
- 11:25 a.m. Role of West Technical Center
  --Gary B. Muckel, Head, Soils Staff, SCS, USDA,
  Portland
- 11:45 a.m. Cartographic Support for the NCSS
  --Richard Folsche, Head, Cartographic Staff, SCS,
  USDA, Ft. Worth

## 12:00 noon (lunch)

Presiding: Tom Collins

Our Role in the Pacific Basin

- --Richard N. Duncan, State Conservationist, SCS 1:30 p.m.
- 1:50 p.m. --Noel P. Kefford, Dean, CTAHR, Univ. of Hawaii
- --Jose Barcinas, Dean/Director, College of 2:10 p.m. Agriculture, Univ. of Guam, Mangilao
- --Ronald E. Stewart, Director, Pacific SW Forest 2:30 p.m. Experiment Station, Forest Service, USDA, Berkeley
- (break) 2:50 p.m.
- 3:30 p.m. Committee Meetings:

# Standing Committee:

Soil Taxonomy--G. B. Muckel

Soil Interpretation--R. T. Meurisse Laboratory Procedures--W. R. Allardice

Research Needs--D. M. Hendricks

#### Conference Committee:

Committee 1, Technology Transfer--D. Ernstrom Committee 2, Publications--J. Latshaw

Committee 3, Alternative Formats--J. Downs

Committee 4, GIS/Remote Sensing--M. Yee

Committee 5, Geomorphic Names--F. F. Peterson

#### TUESDAY, JUNE 14, 1988--MAUI COMMUNITY COLLEGE (Lecture Hall 10A)

### Presiding: H. Ikawa

### Performance of Crop, Pasture, and Forest Lands

Sugar lands--M. Nakahata, HC&S, Maui 8:20 a.m.

Pineapple lands -- D. A. Williams, Maui Pine, Maui 8:40 a.m.

Vegetable crop lands--T. M.Hori, CES, Maui 9:00 a.m.

Pasture lands--J. S. Powley, CES, Maui

9:20 a.m. Pasture lands--J. S. Powley, CES, Maui 9:40 a.m. Forest lands--C. E. Conrad, FS, USDA, Honolulu

10:00 a.m. (break)

- 10:30 a.m. Decision Support System for Agrotechnology Transfer --G. Y. Tsuji, Project Manager, IBSNAT Project Dept. of Agronomy & Soil Science, Univ. of Hawaii
- 11:15 a.m. Use of Soil and Climate Data to Predict Fate of Introduced Rhizobia
  --B. B. Bohlool, Director, NifTAL Project,
  Dept. of Agronomy & Soil Science, Univ. of Hawaii
- 12:00 noon (lunch)

#### Presiding: R. Hoppes

- 1:30 p.m. Revisions in Soil Taxonomy--T. Cook, Soil Management Support Services, SCS, USDA, Wash., D. C.
- 2:00 p.m. Field Trip Information--H. Ikawa
- 2:15 p.m. (break)
- 2:45 p.m. Agency Meetings
  (Each agency meets to discuss its issues)
- 3:45 p.m. Committee Meetings
- WEDNESDAY, JUNE 15, 1988--FIELD TRIP

Tour Leaders: S. Nakamura and H. Ikawa

- 7:30 a.m. Bus leaves Maui Beach Hotel 5:00 p.m. Bus returns to Maui Beach Hotel
- THURSDAY, JUNE 16. 1988--MAUI COMMUNITY COLLEGE (Lecture Hall 10A)

Presiding: B. R. Thomas

- 8:00 a.m. Alternative Data Sources, NRI
  - --K. 0. Schmude, Soil Scientist, Resource Information Div., SCS, USDA, Wash., D. C.
  - --Mon Yee, SCS, USDA, Portland
- 8:30 a.m. National Soil Range Team--S. Leonard and G. Staidl
- 9:00 a.m. Standing Committee Reports:
  Soil Taxonomy--G. B. Muckel
  Soil Interpretation--R. T. Meurisse
  Research Priorities--D. M. Hendricks
  Laboratory Procedures--W. R. Allardice
- 9:30 a.m. Agency Reports

10:00 a.m. (break)

10:30 a.m. Committee Reports

12:00 noon (lunch)

Presiding: B. Buchanan

1:30 p.m. Committee Reports (Continued)

3:30 p.m. Business Meeting--G. B. Muckel

6:30 p.m. (steak fry)

FRIDAY, JUNE 17, 1988--MAUI COMMUNITY COLLEGE (LECTURE HALL 10A)

Presiding: Mon Yee

8:00 a.m. "Expert System" for Soil Management--R. Y. Yost, Dept. of Agronomy, Univ. of Hawaii, Honolulu

9:00 a.m. HNRIS for Land Use Planning--M. A. Khan, Dept. of Agr. Engineering, Univ. of Hawaii, Honolulu

10:00 a.m. (break)

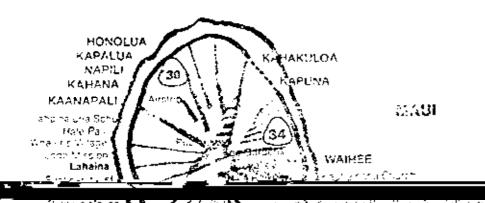
10:30 a.m. Geostatistics in Soil Survey--D. Goss, SCS, USDA, Lincoln

12:00 noon (conclusion of conference)

# WESTERN REGIONAL SOIL SURVEY WORK PLANNING CONFERENCE Kahului, Maui, Hawaii

# FIELD TRIP (Wednesday, June 15, 1988)

7:30 a.m.	Leave Maui Beach Hotel (main lobby).
	Proceed to intersection of Omaopio and Pulehu Roads and 0.6 mile beyond that intersection on Pulehu Road.
8:00 a.m.	STOP lRecently-cleared sugarcane field. Study soil pit of Keahua series, Torroxic Haplustolls.
8:45 a.m.	Leave Stop 1 for Haleakala Crater main observation site.
10:00 a.m.	STOP 2At Haleakala Crater summit.
10:45 a.m.	Leave Haleakala Crater for Kula.
11:15 a.m.	STOP 3Lunch at Rice Park.
12:00 noon	Leave for Kula Experiment Station.
12:15 p.m.	STOP 4At Kula Experient Station. Observe soil pit of Kula series, Typic Eutrandepts. Hear presentation on "Protea Production in Hawaiian Soils" by P. Parvin.
1:30 p.m.	Leave Kula Experiment Station for Haleakala Experiment Station on Piiholo Road near Makawao.
2:15 p.m.	STOP 5At Haleakala Experiment Station. Observe soil pit of Makawao series, Humoxic Tropohumults. Observe/hear experiments of NifTAL Project (B. Bohlool), IBSNAT Project (R. Ogoshi), and Forest Service-Agronomy Project (C. E. Conrad).
4:15 p.m.	Leave Haleakala Experiment Station for return to Maui Beach Hotel.
5:00 p.m.	Arrive at Maui Beach Hotel.



Calebana

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WEST REGION SOIL SURVEY
WORK PLANNING CONFERENCE

Ву

Especially prepared for

Stop 1. Keahua soil pit

Stop 4. Kula soil pit\_ KIHEI Raymorking Stop 1 Kalema Poper Park 72.00 Stop 5. Makawao soil pit KEANAE Kamable Buoch Park Stops KEAWAKAPU WAILEA MAKENA William to controlla La Perouse 53y HANA **KAHOOLAWE** Steven Fire o Distances and Driving Times

#### From KAHULUI

To Lahaina Kula Haleakala Hana Wailuku 23 miles, 35 minutes 18 miles, 23 minutes

18 miles, 23 minutes 30 miles, 1 hour. 45 minutes

52 miles. 2 hours. 15 minutes 5 miles, 6 minutes

Kihei Wailea 3 miles. 20 minutes 18 miles. 35 minutes From Lahaina to Kaabupali 4 miles, 7 minutes

From Kaanapaa to Napili 8 miles, 12 minutes.

1935 HAWAT MISITORS BUREAU PRINTED IN U.S.A. SEUTES: Reabua

NSSI 10 D: 84P0041

LONSITUDE: 156-22-33-W

ELEVATION: 0375 m HSL

PERKEABILITY: Noderate

MLKn: 158

SOIL SURVEY 4 SUBJUT-004-002

LOCATION: Island of Maoi HI. Nelcakele Wanch Wietekoa Pastore; from Kula Hwy 5.8 km kW on fiaalae kd.; 45 km h of Rd.

LATITUDE: 20-46-43-W

PHYSICGRAPHY: Upland slope in level or undulating uplands

SLOPE CHARACTERISTICS: 06%

PARCIFITATION: )80 mm Using moisture region

WATER TABLE DEPTH:

DRAINAGE: Well drained

STONLIESS

PARERT MATERIAL: Residuum from volcanic basic rock with volcanic ash influence SERIES CLASSIFICATION: Fine, Reclinitie, Isohyperthermic Torroxic Maplustoll

DIAGNOSTIC MORIZONS:

DESCRIBLO BY: S. Nakamuta

SAMPLE DATE: 10/63

Textures are "apparent field textures." This poden is representative of the Keakua berres. Colors are for dry soil unless otherwise stated.

Api--0 to 10 cm, reddish brown (SYR 4/3) silty clay loam; dark reddish brown (SYR 3/2) molet; moderate coarse and very coarse platy structure; hard, friable, slightly sticky, slightly plastics cany time and common very time roots; many very fine tubular pores; strongly efferweenest thydrogen peroxide); neutral; "lear scooth boundary. 8420180

Ap2--10 to 29 cm; reddish brown (SYR 4/3) stity clay loam; dark reddish brown (SYR 3/2) woist; weak fine and medium schangular blocky structure; hard, frieble, slightly sticky, slightly sticky; many very fine and fine moors; many very time tutular pores; atrongly effervescent thydrogen peroxidely neutral; gradual wavy boundary. 84 PO181

Bwl--79 to 48 cm; reddish brown (Syn 4/4) silty clay loam; dark reddish brown (Syn 3/3) moist; weak (ine and medium sunangular blocky structure; hard, friable, slightly sticky, slightly plastics many very fine and correst fine toots; many very time tubular person 8) percent probles; strongly

plastic; many very line and many time roots; many very time tenutar pores; attendity experienceme thydrogen peroxide); neutral; clear smooth boundary. 841/0183

2893--82 to 122 cm; brown to dark brown (7.5%k 4/4) and brown to dark brown (10%k 4/3) silty clay loam; dark brown (7.5%k 3/4) and very dark brown (40%k 2/2) moist; strong very fine and fine subangular blocky structure: very hard, friable, slightly sticky, slightly plastic; common very (the roots; many very fant tubular pores; slightly effervescent (hydrogen peroxide); neutral; gradual smooth boundary. A4POLE4

28w4--322 to 150 cm; grayish brown (109m S/2) silty chay loam; very dark grayish brown (109m 3/2) moist; moderate very fine and fine subingular blocky structure; very hard, friable, sticky, plastic; few very fine roots; common very fine tubular pores; slightly effervescent thydrogen peroxidel; neutral.

15% light yellowish brown (1896-6/4) soft weathered pebbles. Feels gritty due to aggregate stablility,

80110185

THE, RELEBITIC, EQUIVERBERIC, TORGOTO PAPERTILIS

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ANALYSIS: S= ALL OR STEVED COM DOTTS
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1814ATSVE NECET: 6 MEXICAMINATE 5 MILLIONET 4 AMERICAN 3 MIDERATE 7 SYSTE. 1 TRACE

24 PUT (1-75AM)

EASILY CURRED SICTION: 189/DI 25-100 PCT CLAY

SKRIES; Kula 1165C IO \$: 8370878

SOLL SURVEY & S8 DEL-UVE - 1995

CONTION: Island of Maul HI. J. Mashimoto Parm Rula; from Rehautiko Ave. 🧈 km E of

Hapapa Rd., Site is 30 m N of Rd.

LATITUDE: 20-45-52-N PHYSIOGRAPHY: Upland slope

SLOPE CHARACTERISTICS: 194

PRECIPITATION: 760 pm Udic moisture regime

WATER TABLE DEPTH:

DEAINAGE: Well drained

STONIGESS

PARENT MATERIAL: Volcanic ash over residoum from basic volcanic rocks

SERIES CLASSIFICATION: Hedial, isothermic Typic Entrandept

DIAGROSTIC HORIZONS:

DESCHIBED BY: S. Makamura

SAMPLE DATE: 09/83

LONGITUDE: 156-16-16-W

ELEVATION: 1160 M MSL

PERKEABLELTY: Moderately rapid

MLKA: 157

Cotors are for moist soil unless otherwise stated. Textures are "apparent field textures." B horizon shows thaking on dried faces of pit, but and Bull horizons were split for sampling. This pedon is in the higher elevation limits.

Apt--0 to 6 cm; dark brown (7.5YR 3/2) time sandy loam; moderate very fine granular structure; very friable, nonstricky, nonphastic; many very fine roots; many very fine tubular pores; slightly acid; abrupt smooth boundary.

Ap2--8 to 27 cm; dark brown (7.5YR 3/2) very fine sandy loam; weak very fine granular structure; very friable, nonsticky, nonplactic; many very fine roots; many very fine tubular pores; 02 percent publics; slightly sold; abrupt smooth boundary, 8)p4459

bul--22 to 37 cm; dark brown 17.5YR 3/4) wilt loam; weak course prismatic structure parting to weak fine and mudium subangular blocky; very friable, weakly smeary, slightly sticky, which plastic; many very fine roots; many very fine tubular poses; 02 percent publics; neutral; clear way boundary.
8494460

Bwl--37 to 66 cm; dark brown (7.598 3/4) allt leam; weak coarso priematic attructure parting to weak fine and medium subangular blocky; very friable, weakly amounty, slightly sticky, slightly plastic; many very fine roots; many very fine cubular pures; 62 percent pebbles; mentral; clear wavy boundary.

Same as above horizon. Split for sampling only.

Sir4461

Bw2--66 to 9) cm; dark brown (7.5YR 3/4) silt loam; moderate coarse prismatic attructure parting to moderate fine and medium subangular blocky; very friable, weakly smeary, alightly sticky, alightly plastic; common very fine roots; many very fine tubular and few fine tubular pores; neutral; diffuse smooth boundary. Pockets of strong fine and very fine angular blocky structure occupy 10 percent of this borrach.

83P4462

ge3.-9) to 124 cm; dark brown (7.5Yk )/4) silty clay loam; moderate medium and coarse prismatic structure parting to moderate very fine and fine subangular blocky; very friable, weakly ameary, slightly sticky, slightly plastic; many very fine and fine roots; many very fine tubular pores; slightly acid.
8394463

Be)--124 to 158 cm; dark brown (7.5Ym 3/4) Bilty clay loam; moderate medium and course prismatic structure parting to moderate very fine and time subangular blocky; very friable, weakly smeary, slightly sticky, slightly plactic; many very fine and fine roots; many very fine tubular pares; alightly acid.

Same as above harizon. Split for pareling only.

KOLV

PRIMAL, ISOMETHIC TYPIC EMPRANDEPT SAMPLED AS:

\$ 8301-004 -005 DATE 68/03/84

SAMPLE NO. 80P4458-4468 PETAN NO. 80P 878 PROJECT NO. 80P 155 MAUL SOIL-CLIMATE

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE NATIONAL SOIL SURVEY LABORATORY LIPOUN, MERRASKA 68508

PAGE 1 OF 2 PAGES

GERORAL METHODS 181A, 2AL, 28

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		ζ	- <b>-</b>	1(.)	Or C	(PES		>			PCY	<0.4NM	( (	6/CC •	>	CM/CM	ζ	-ser o	ir (2 <del>14</del> 1	ı – –>	CM/CH
634450	_	9.64				9.4	3.9	0.2	26.03	12,40		50				0.074			51.2	36.2	0.12
834459 814460		9.41 7.78				10.1	3.8 4.4	0.3	27.81	13,04		h#1				0.058					
B3446L		7.51	0.220			30.3			E 3 44			FE.				0.335					
834452		5.33	0,418			11.5	4.5 4.1	0.3	84.88	40.25		NA PE.				0.296					
E 14463		5.26				12.0	4.1	0.21	00.60	60.00				0,62	1.24	0,260					
834464 834465		5.21 8.00	0.422									NP			1.22	0.355					
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			· · · · · · · ·					<b>-</b>											··		
		( - (3)) - CA	NON' E PE	አገነውር IX የጫ		NSES -¦ S™			( SIM			) AL. S SAT							( ·   NAF		
SNOLL				SOSA	SDSA	BASES			CATS		+ AI			OVE	<2+25	/(N		ΑH		.OLM	
14.).	N).			6P2B								5G1	503	_ SCI	6EIG	138		/3H 18	8C1D	BCLF	8015
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834458		26.3	2.8			29.6				75.5				39					10.6	5.6	6.1
834459		34.9	3.5			35.9				72.3				54					10.5	6.0	
834460 834461	_	31.2 30.4	3.0	0.4		34.7 33.6				72.0 66.2				48 49					0,11 0,11	6.1 6,2	6.7 6.8
834462		24.2	2.6			27.3				67.9				40		27000			10.9	6.0	
834463		10.5	2.7			13.4				54.3				25					11.2	5.6	6.1
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834465 634466						23.3				74.3 77.1				)1 58					11.1	6.0 6.4	6.4 6.9
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		P- DE73		ACID rvm			K/NI CVT	AVA 36	i <b>-</b>				(		<b>-</b>	- (1A)	Y		>(	[ <u>!</u>	) -3
SAMPLE,	H7.N	RETT Vat		AL.	vactabi St	er:	FXT ስር	PIJOS (RAY)	ι									)(DI )			VEATH
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01144		<b>ζ</b> —-												(- K	PATIV	e MEU	VID -7	<b>&lt;</b>	1	- V	>
834458 834459	1 2	100 99		6-4 6-6	2.0	4,5 5.7	5.8 5.1	2						NEX 6							
834460	3	ιóί		8.5	2.9	6.3	6.1	ī						NX 6							
834461	4	100		7.0	2.1	5.0	6.6	_						100, 6							
934462	5	100		7.9	2.4	6.6	6.3	ż						-50 /							
834463 834464	7	95 100		5,4 8.2	1.5 6.2	4.B 6.6	5,9 6.1	ì						10X 6							
014465	é	100		7.5	0.1	4.9	6.6	•													
634466	9	100		9.1	0.2	7.2	6.2														
B34467		99		5.9	1.6	4.0	6.6			t	<i>-</i> .										
B)#16A	2.7	100	,	6.4	1.9	4.2	6.5			-t	C)										

SIRIES: Bakawao

NSSE TO \$: 8190982

LONGITUDE: 156-17-51-R

ELEVATION: 640 to HSI.

PERMEASICITY: NoJerately rapid

MLPAT 367

SOIL SURVEY # 58381-004-012

LOCATION: Isl. Mani hit. Miftal prog Ullkes: 0.3 km S% of Pitholo Ad. entrance 5 m above

face 9d. 100 m 89 of tanks.

EATTIMUDE: 20-50-40-N

PHYSIOGRAPHY: Upland slope in level or undulating uplands

SLOPE CHARACTERISTICS: 5 1

PRECIPITATION: 1830 mm Udic moisture regime

WATER TABLE DEPTH: DRAINAGE: Well drained

STORIBLES

PARENT MATERIALI Residumm from volcante basic rock

SERIES CLASSIFICATION: Clayey, oxidic, isothermic Humoxic Tropohumult

DIAGNOSTIC MORIZONS:

DESCRIBED BY: S. Nakamora

SAMPLE DATE: 09/83

hiftal project BHAES Halcakala Br. Makavao. Colors are for moist soil unless otherwise stated. Textures are "apparent field textures." Bt2 split for sampling. No BS samples on C/8 and Cr.

Ap--0 to 16 cm; dark reddish brown (SYR 3/3) stilty clay; reddish brown (SYR 5/4) dry; strong very fine and fine subangular blocky structure; very hard, firm, very sticky, very plastic; many very fine roots; many very fine tubular pores; strongly acid; clear smooth boundary.
0394492

hw--16 to 30 cm; dark reddish brown (SYR 3/3) silty clay; reddish brown (SYR 5/4) dry; weak fine and medium subangular blocky structure; very bard, frintle, sticky, plastic; many very line roots; many very fine tobular pores; very strongly acid; gradual smooth boundary.
5384493

Bil--30 to 51 cm; dark reddish blown (2.5YR 3/4) silty clay; reddish brown (2.5YR 4/4) dry; moderate very fine and fine subangular blocky structure; very hard, firm, very sticky, very plastic; very lew thin clay tilms; many very fine roots; nany very fine tubular porce; very strongly acid; clear wavy boundary, 83P4494

B12--51 to 74 cm; dark reddish brown (7.578 3/4) and dark red (2.578 3/6) silty clay; reddish brown (2.578 4/4) dry; strong very fine and fine subangular blocky structure; very hard, firm, very cricky, very plastic; common discontinuous clay films on faces of pedar common discontinuous clay films in root chancels and/or pores; few very fine roots; many very fine tubular pores; very strongly acid; clear smooth boundary.

Ruots natted in horizontal places in several places within horizon. Compact in place.

\$22-74 to 97 cm; dark reddish brown (2.5% 3/4) and dark red (2.5% 3/6) silty clay; reddish brown (2.5% 4/4) dry; strong very fine and fine subangular blocky atructure; very hard, firm, very stricky, very plastic; common distinct clay films on faces of geds; common distinct clay films in root channels and/or pores; few very fine roots; many very fine tubular pores; very strongly acid; clear smooth boundary.

Roots matred in horizontal planes within borizon. Compact in place.

C/B--97 to 12) cm; dark teddish brown (2.5YR 3/4) and dark red (2.5YR 3/6) silty clay; red (2.5YR 5/6) dry; strong very time and fine subangular blocky structure; very hard, firm, sticky, plastic; few very fine toots; many very fine tubolar pores; 60 percent peobles; clear smooth boundary.

831-4497

fir-123 to 153 on; very mark gray (10YR 3/1) weathered bedrock.
Contains yellowish brown 10YR 5/6 weathered moterial from exide; red 2.5YR 4/6 and Mark red 2.5YR 3/6 conting of soil naterial from shove.
Byp440d

MAKAWAO

EVICE 1 OF 2 PVICES

SAMPLIN AS: CLAYEY, OXIDIC, ISOMERNIC HARDKIC TROPORTER. SAMPLE NO. 8)94892-4498 U. S. PEPARIMENT OF AGRICULTURE 5 8 381 - 604 - 612 DATE 08/03/64 PELON 10. 83P 882 SOIL CONSERVATION SERVICE MAUL SOLL-CUPATE PRIMER'T NI), 839 155 NATIONAL SOIL SURVEY LABORATORY LINCOLN, NEURASKA 66508 CHESIAL METRICES 181A, 2A1, 2B -1-- -2-- -3-- -6-- -5-- -6-- -6-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-.1- RT 08 75 WIDLE 26.8 69.5 3.7 She 26.6 68.9 6.5 POINTER 8)4492 15 0-16 9.8 0.2 1.2 0.9 0.9 59.7 7.3 2.4 2.6 9.0 5.3 6.7 0.5 -- --28 16- 30 ЬA 634443 61.6 1.0 0.6 6.7 17.2 66.9 15.9 ASING 57.9 35 30- 51 [??t 2.4 814494 2.0 4.9 12.3 17.6 10.7 3,5 12.0 20.6 21.3 16,7 35.0 48,3 TEXTURE 834495 45 51- 74 8372 29.9 5.1 2.8 --12.0 24.6 63.4 59 74- 97 6.0 — 60 -- $\mathbb{R}^{2}$ 4.5 634598 20.110.5 8.6 13.9 20.9 19.7 17.6 15.7 8.6 10.6 25.9 17.0 17.4 65 97-123 C/B 60 **BR4497** 0.6 10.5 80.9 8.6 87 63 13.1 20 29 934:98 75 121-153 3.7 22.3 74.0 00 46 OWNERS BROWN 16.0 1.3 8.1 0.68 0.76 44
16.1 1.2 8.1 0.53 0.72
18.0 0.9 78 0.64 1.01 30
18.9 1.0 78 0.59 1.23
18.4 1.1 78 0.79 1.76 31 1 3.58 0.336 2 2.22 0.231 1.17 1.37 0.054 1.33 1.40 0.017 36.6 20.4 0.22 A t4442 31.6 17.8 0.19 H34493 25.4 17.3 0.13 8 14 194 3 1.30 0.110 1.65 1.72 0.014 034495 0.58 1.61 1.78 0.034 78.5 20.6 0.11 834496 5 0.68 6.671 1.68 1.83 0.029 29.6 21.1 0.13 834497 6 3,14 71.50 57.17 1.70 834498 7 1.75 3.9 1.9 18 11.59 13.00 ..... REMEDIC: Clays did not disperse completely because of tree and acorphous mitorial. See mineralogy for iron content of clay. See podra description for texture, (XED: (- - - - E) - - -) MMIDS NAP CACLE 1120 /CM 81 POID BOIF BOIP 1:2 1:1 0.7 0.2 0.1 3.7 28.9 0.8 32.6 18.1 4.5 18 0.1 0.3 38 1.1 27.4 1.4 28.5 13.1 2.5 56 0.1 0.1 — 0.6 22.9 1.6 23.5 1).0 1.6 81 814452 5.1 20 8.6 4.7 2 0.7 6.1 0.3 914491 8.8 4.3 4.8 8.2 3.9 4.5 3 R. #1449A a 9.4 0.5 24.2 9.8 1.6 0.6 23.1 9.5 1.3 56.0 4 -- 1.1 23,1 -- 0.7 22.4 TH 0.7 55,3 634125 0.8 -0.1 - 0.231 31 8.1 4.1 4.7 614406 0.5e.te.t46 ? 0.3 4.7 032437 0.4 0.1 0.2 0.2 0.6 75 634358 0.6 52.8 42.9 Ttt Τk 11.0 - 5.2 - 5.1(-----) (---- X-RAY ----)(---) -)
(---- X-RAY ----)(--DTA --) TOTAL DOM
(----- CU ----)
7A21 7A21 7A21 7A21 7A3 7A3 7E1A 7A1A
(- RELATIVE ANOMAS -> (-----)(T ----> P- (-ACID GGAIATE--) KINI PETERF- PENNACTABLE EXT MARI. EXT in a AL. SAMPLE MAN printy i \* 124. 120. (5) P144 034492 0.5 0.6 Q2 2 GE 1 0.1 1.2 831493 314 58 0.4 1.4 0.5 В O2 2 Alatha - 1 48 0.7 TR 2.4 0.32 Q2 2 3.2 3.0 834495 57 0.3 0.2 OZ 1 NX 6 7R 614496 TK 0,4 0.5 6)4497 814478 100 1.4 7.5 6.6

PAMELY CORNEC, SELTION: DEPTH 30-80 RT CLAY 16 RT .1-75MM 32 ESCHROTTO ESTA LICENTY POR LAYER 6,

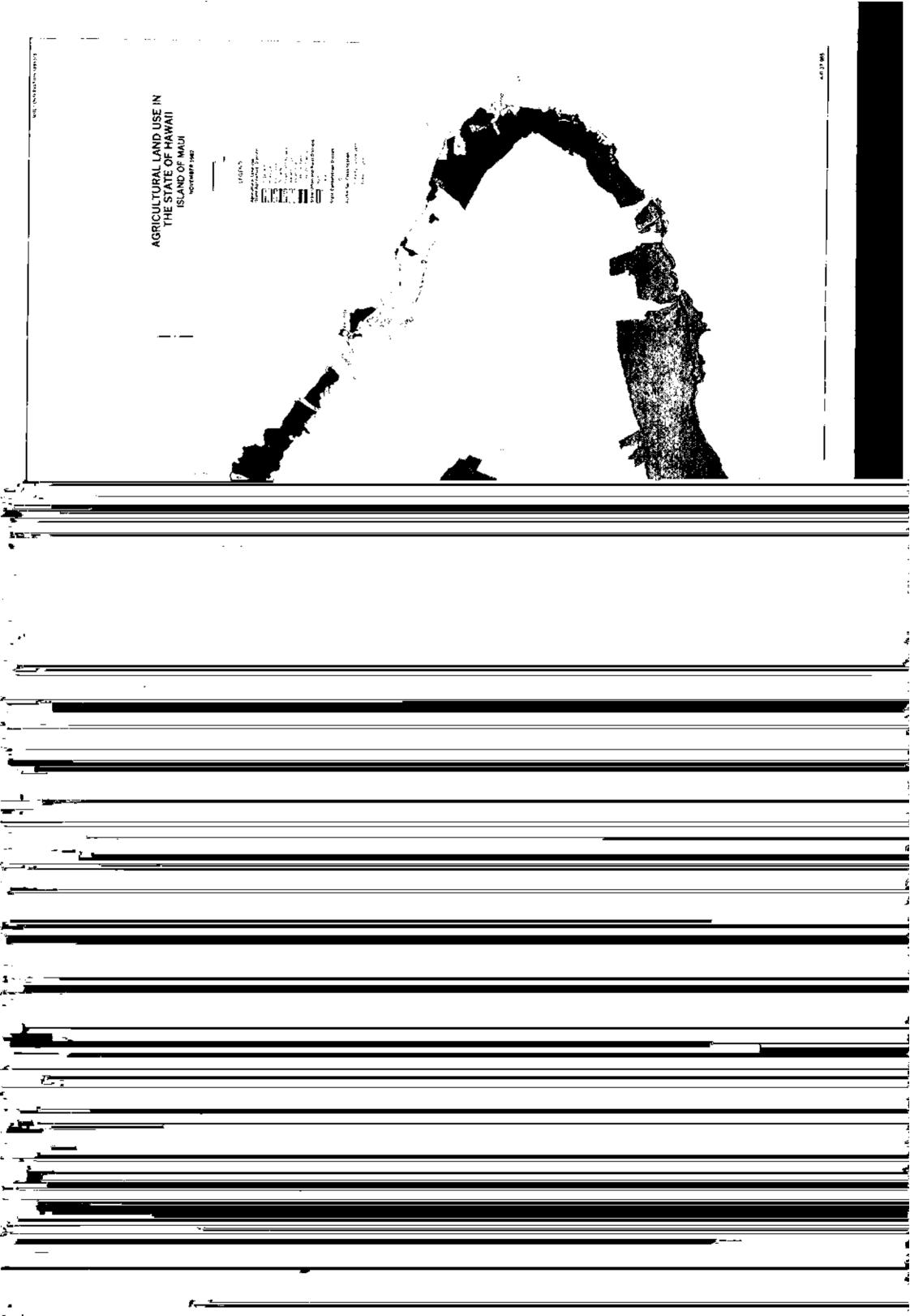
ANALYSING SHIPLOON STONED COM BUSIS

MINERALITY: KIND OF RUGERA, QZ QOMRYZ CH CHEMINTE IN ARCHITIS

Table II. Laboratory data of Makawan silty çlav

Soil name: M Soil no. S	akawao 59Ha-4/241-4)		icanor: Bu on: Haleaka		dimmidts, claves of Station	, oxidic, ism	нетыіс						
		Particle site analysis			Bulk		Vater conte	nt	Отраніс	Total		Extractable iron	
Depth	Horizon	Sand	Silt	Clay	density	.1-bar	.3-bar	15-bar	C	N	CN	Fe	Fc <sub>2</sub> O <sub>3</sub>
****CB1***			x t < 2 mm-	.,,	g (1		ри :		·px t	]x[			X
6-15	Apl	4.3	63.7	32.0	1,39			17.5	2.88	0.30	10	24.7	25.3
15-33	Ap2	4.3	64.3	31.4	1.41			19.7	2.15	0.22	10	23.3	33.3
33-51	B211	3.8	43 i	53.1	1.01			25.1	2.08	0.19	11	27.0	38.6
51-112	B22t	18.2	13.3	38.7	tina.				2.51	0.17	15	13.7	19.6

		F.	xtractable i	75.47		Extraciable	Cation-ex capac		Extractable	Base satu	aoîtar	рН		
Depth	Ca	Mg	Na	K	Sum	acidity	NH <sub>2</sub> OAc	Sum	Al	NH <sub>2</sub> OAc	Sum	H <sub>2</sub> O	kCi	Difference
em					·····meg	1(P) g var!	,,							
0-15	2.54	0.29	0.06	0.14	5.03	21.9	17.19	27.9	0.35	18	11	1.25	1.03	-0.22
15-33	0.11	0.05	0.03	0.08	0.59	25.0	15.50	26 7	0.75	4	2	4.19	3.99	-0.20
33-31	0.28	0.03	0.12	0.05	0.48	36.0	21.89	36.5	0.84	2	1	4.03	3.84	-0.19
51-112	0.18	0.05	0.07	0.01	0.65	33.7	30.37	34.1	0.31	2	2	1.71	4.26	¥n,t5



This map is intended for general planning. Each defineation may contain toils having ratings different from those shown on the map. Use detailed sail maps for operational planning. Hydrandeats, Trapaqueds assexiation. Sently slaping to steep, well-drained to poarty drained soils that have a modatataly fine fextured or fine textured subsoil; on intermediate and high uplands Watakoo, Kechua-Malakai association i Madarately deep and deep, nearly fovel to moderately steep, well-deained soils that have a moderately fine lexiting subsculp, on low uplands Mana-Makaalae-Kailua association. Maderately deep and deep, gently stabing to steep, well-drained soils that have a moderately fine textured or fine textured subsoil or underlying material; on intermediate uplands. Puleby-Ewa-Joucos ossex totinan Deep, nearly level to moderate. Y stopma, well-drained and excessionly drained spits that have a moderatery fine restained to coarse-testured subsoil or underlying material; on allowial fors and in basins Pauwela-Harka association: Deep, gently staping to moderately steep, well-drained soils that have a fine-textured subsoil; on low uplands Pour Parkula-Pone association: Deep, gently slaping to steep, well-drained soils that have a medium-testured or moderately fine testured subsoil or underlying material; on intermediate and high uplands Kampale.Danapuka aksaciation. Gently slaping to moderately steep, well-drained, very stony and extremely stony soils that have a fine-textured subsail and are shallow to dong over fragmental lava; on low and intermediate uplands. Honolug-Olelo association. Deep, gently stabing to moderately stopp, well-drained soils that have a fine-textured subsoil, on intermediate uplands. Rock land-Rough mountainous land association. Very shallow, sheep and very steep, rack land and raugh mountain land Loumoia-Kaipaiai-Olinda association. Deep, gently slaping to very steep, well-drained sails that have a maderately fine tratured or medium-textured subsoil, on intermediate and high uplands. Kebwakapu-Wakeno association. Genity slaping to moderately steep, well-drained soils that have a fine-textured to moderately restored subsail and are shallow to doep aver fragmental lava; on low uplands. SOIL ASSOCIATIONS January 1971 **1**<sub>k</sub>. ) Year

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Tho, James USDA SCS 217 Pederal Building Vailuku, Naui 86793 ALUCE OND WELLOWE TO THE WESTIGHN REGIONAL SOLE SURVEY WITH. PLANNING COMPURENCE:

4Y NAME IS HARRY SAID, 555, FROM HONDLOLD, NI. I WILL BE SHE PRESIDENCE OF LOCK THIS HORNING AND TRY 10 FERR THIS SESSION MOVING... ON TIME.

WHILE YOU ARE HERE YOU WILL HEAR MANY HAWAIIAN WORDS SPONEN. THREE COMMON, YET IMPORTANT WORDS ARE "ALOHA", "BHANA", AND "MAHALD".

"ALCHA" IS A HAWAIIAN WORD RECOGNIZED AROUND THE WORLD AS A WORD OF GREETING. IT MEANS HELLD, WELCOME, FAREWEL L., AND GOODBYE: ALSO LOVE, PEACE, HARMONY, FELLOWSHIP.AND BROTHERHOOD.

"OHANA" MEANS FAMILY. THE WORD IS NOT CONFINED ONLY TO BLOOD RELATIVES BUT TO A CLOSELY RELATED GROUP SUCH AS THIS WESTERN REGIONAL SOIL SURVEY CONFERENCE.

"ALOHA" EXPRESSES THEFEELINGOFFRIENDSHIP AND FAMILY (DHANA) THAT WE SHARE IN THE WESTERN REGIONAL SOIL SURVEY WORKPLANN ING CONFERENCE.

LET US REMEMBER TO CONDUCT THIS WESTERN REGIONAL MEETING AS AN "OHANA" WITH

"ALOHA AND MUCHLOVE",

"ALDHA AND CARING FOR OTHERS",

"ALOHA AND FELLOWSHIP WITH EACH OTHER", AND WITH

"ALOHA F-ROM DEEP WI THIN OURHEARTS".

LETUS NOT FORGET THIS FEELING. THIS SPIRITOF" ALOHA" AND "OHANA" AS WE START OUR SESSION TODAY. YET, UN AN ISLAND LIKE THIS, IT IS TOO EASY TO RELAX AND FORGET WHAT WE CAME HERE FOR. WE HAVE A MISSION(S) TO ACCOMPLISH. WE ALLDID OUR HOMEWORK BEFORE WE. CAME HERE. LET'S CONTINUE TOWORK HARD AND FINISH THE WORK BEFORE US AS AN "OHANA WITH ALOHA."

NOW IT IS TIMEFOR THE THIRD WORD, "MAHALO", WHICH MEANS THANK YOU. "MAHALO" FOR COMING TO THE WESTERN REGIONAL SOIL SUAVE Y WORK PLANNING CONFERENCE.

ALOHA AND WELCOME TO HAWAII.

I AM DELIGHTED TO EXTEND MY WARMEST ALOHA TO ALL OF YOU HERE FOR THE WESTERN REGIONAL SOIL SURVEY CONFERENCE. WELCOME TO HAWAII! WELCOME TO PARADISE! MANY PEOPLE IN THE NHQ HAVE AN ERRONEOUS IMPRESSION THAT YOU ARE ALL HERE FOR A VACATION. BUT JUDGING FROM YOUR AGENDA, I SEE A LOT OF 1NTERESTING TOPICS AND LONG AND HARD DAYS AHEAD FOR YOU,

THE THEME OF THE CONFERENCE "WORKING TOWARD AGROTECHNOLGY TRANSFER" HAS SPECIAL MEANING TO SCS IN HAWAII.

WE COVER AN AREA GREATER THAN THE SIZE OF THE CONTERMINOUS UNXTED STATES - FROM PALAU, GUAM AND SAIPAN, APPROXIMATELY 3600 MILES WSW FROM HAWAII- ALL THE WAY TO AMERICAN SAMOA WHICH IS ABOUT 2300 MILES SOUTHWEST OF HAWAII.

THESE AREAS NEED A LOT OF NATURAL RESOURCE CONSERVATION HELP AND WE HOPE THAT WE WILL BE ABLE TO TRANSFER OUR KNOWLEDGE GAINED HERE IN HAWAII TO SIMILAR TYPES OF SOILS IN THE PACIFIC BASIN AREA. BECAUSE OF LIMITED FUNDING AND PERSONNEL, WE LOOK FORWARD TO THE RESULTS OF THIS MEETING TO HELP US GET OUR JOB DONE MORE EFFECTIVELY.

THERE IS A SAYING, "MAUI NO KA OI" WHICH MEANS MAUI IS THE BEST. BUT THIS WAS NOT THE CASE A LONG TIME AGO. THE FARMERS IN KULA REALIZED THAT THEY HAD A SERIOUS EROSION PROBLEM AND FORMED THE FIRST SOIL CONSERVATION DISTRICT IN HAWAII. TODAY THERE ARE 15 SOIL AND WATER CONSERVATION DISTRICTS IN HAWAII AND 5 IN THE PACIFIC BASIN. ON MAUI THERE ARE 4 DISTRICTS.

WITH ITS MAJESTIC HALEAKALA WHICH RISES TO 10,250 FEET ABOVE SEA LEVEL, MAUI ENJOYS VARIED TEMPERATURE REGIMES-FROM THE HOT AND ARID ISOHYPERTHERMIC TO THE WET AND COLD ISOMESIC... (HOW'S THAT FOR A NON-SOIL SCIENTIST?) . ..AND EVEN SNOW ON HALEAKALA DURING THE WINTER MONTHS. BECAUSE OF THESE DIFFERENCES IN CLIMATE AND PARENT HATERIAL, HAWAII IS THE ONLY STATE IN THE UNION WITH ALL 10 ORDERS OF THE SOIL TAXONOMY. I UNDERSTAND THAT YOUR FIELD TRIP LATER THIS WEEK

WILL TAKE YOU UP THE SLOPES OF HALEAKALA TO SEE THE RESULTS OF SOIL FORMATION DUE TO THE DIFPEKENCES IN CLIMATE.

BECAUSE OF THE VARIETY OF SOILS AND CLIMATE, MAUI PRODUCES MANY DIFFERENT KINDS OF CROPS-SUGARCANE:, PINEAPPLE, BANANAS, PAPAYAS, MACADAMIA NUTS WHICH ARE FOUND IN THE TROPICS TO MORE TEMPERATE CROPS SUCH AS ICEBERG LETTUCE, HEAD CABBAGE, CELERY AND THE WORLD FAMOUS KULA ONIONS.

THE GRAZING LANDS SUPPORT ANDROPOGON, BUFFEL, CACTUS, AND MESQUITE IN THE DRY HOT AKEAS TO KIKUYU AND PAHGOLA IN THE HUMID AREA. THERE ARE EVEN KENTUCKY BLUE GRASS AND ORCHARD GRASS IN THE COOLER HIGHER ELEVATIONS HERE.

FOREST LANDS IN HAWAII HAVE DEEN TRADITIONALLY USED PRINCIPALLY AS WATERSHEDS. HOWEVER, THEY REPRESENT A POTENTIAL SOURCE OF TIMBER. SOME OF THE EUCALYPTUS SPECIES ARE KNOW PRODUCE OVER 20,000 BOARD FOOT PER ACRE PER YEAR. LOCAL SPECIES OF IMPORTANCE ARE THE KOA AND OHIA TREES. REDWOODS ARE ALSO DOING WELL IN SPECIFIC BELT. THE PINE TREES ALSO ARE ADAPTED ON 'THE DRIER SLOPES OF HALEAKALA.

WHILE NATURAL RESOURCES ARE PLENTIFUL ON MAUI, ALL IS NOT "PARADISE. TO ALLEVIATE THESE PROBLEMS, MAUI HAS RC&D AND WATERSHED PROTECTION (FLOOD CONTROL) PROJECTS IN ADDITION TO OUR REGULAK CO FROGRAMS.

IN THE UPCOUNTRY AREA, SCS IS WORKING WITH THE COUNTY OF MAUL AND THE STATE TO SOLVE THE WATER DISTRIBUTION AND WATER MANAGEMENT PROBLEMS. CONVERSELY, FLOOD CONTROL IS A PROBLEM IN THE LAHAINA-KAPALUA AREAS ON THE WEST SIDE. YOU WILL SEE THESE FLOOD CONTROL CHANNELS BEING CONSTRUCTED IF YOU HAVE A CHANCE TO DRIVE TO KAPALUA.

MAUI IS ALSO KNOWN FOR ITS SUPERB TOURIST FACILITIES. IT HAS SUPERB SANDY BEACHES, CHALLENGING GOLF COURSES, MANY HIKING TRAILS, AND EXQUISITE ACCOMMODATIONS. BECAUSE OF ALL THESE, THEY SAY MAUI NO KA 01. MAUI IS THE BEST! ENJOY YOU STAY ON MAUI.

RICHARD N. DUNCAN

#### OPPORTUNITIES FOR A NEW AGE FOR SOIL INFORMATION TRANSFER\*

by
N. P. Kefford
Dean and Director
College of Tropical Agriculture and Human Resources
University of Hawaii

Presented to the Western Regional Soil Survey Work Planning Conference

June 13. 1988

Maui. Hawaii

On behalf of the College of Tropical Agriculture and Human Resources. University of Hawaii, I am pleased to welcome the Western Regional Soil Survey Work Planning Conference to Hawaii. I thank you for inviting ma to present a welcome address.

A good rule of public speaking is to know your audience. Therefore, let me tell you what I know about soil scientists. From my observations. the most distinctive characteristic of soil scientists is that they become ecstatic at the very mention of a soil pit. I learned early not to get in the way of a group of soil scientists that has just learned that there is a soil pit around. Last week. my colleague Dr. Haruyoshi Ikawa made the final preparations for this conference, not by checking that the lecture hall or the hotel arrangements were in order, but by solemnly digging. not one. but two soil pits. Clearly, we consider this conference to be particularly important because we have designated it a two-pit conference. One of the nation's most prominent soil taxonomists confessed to me that on his honeymoon he strove to impress his wife with his manliness by taking her into the field and having her watch him dig a soil pit. It is a real spectacle to observe soil scientists swarm into a soil pit and scrape away at the profile-face with their penknives. Clearly. all of the senses of a soil scientists are at a peak when he is in intimate. confined contact with the past, present, and future of a soil. What goes on in the mind of an expert soil scientist is central to my theme. and I hope to challenge you with the expanding opportunities for directing and using the intensity of study. experience, interpretation. and judgment that constitutes expertise.

Two questions should be asked as this conference commences. First, how can we take advantage of modern technology in carrying out that which a soil survey can and should do? Second, how do we prioritize research for a future that can be based upon the opportunities that modern

<sup>\*</sup>This paper is **based** on the ideas and experience of Dr. Russell Yost, Department of Agronomy and Soil Science, College of Tropical Agriculture and Human Resources.

technologies offer to us? As background to seeking answers to these questions, permit me to summarize the nature of progress and achievement to date. Vast amounts of data have been collected and, through soil classification, one type of order was brought to this data. That is. an overwhelmingly enormous mass of data became ordered into an array of systematic and manageable classification units. However, with computer technology, the amount of data is no longer a constraint. Computers can now have a major input to soil-based information transfer because they can sort massive amounts of data and make it systematic and orderly in a variety of ways. If we wish to use the data for classification, we can use the computer to do it. If. however, we need the data to assist us in a different use, we can use the computer to order the data differently.

Right now. soil survey provides the basic information resource for soil taxonomic classifications and for land capability. Then. land capability and soil taxonomy are combined as a basis for land-use decisions. For the future, computers offer opportunities for alternative means of making land-use decisions. But how do we best use these opportunities that the computer offers? Should we not have potential users of the data answer this question? What do these users need so that they can carry out their responsibilities for land-use decision making? Users now need direct soil data in addition to information based on land capability class. Users want to order and display data in a manner that relates specifically to their uses--not only to a general use. Classical displays such as maps will retain their usefulness in the future, but there are now opportunities for displays that are flexible and dynamic rather than fixed and static. Therefore, one future option available to us is to make land-use management more specific than is possible using a soil classification/land capability base. We know these computer-based information systems for land-use decision making as Geographic Information Systems. We look forward to these systems becoming sufficiently specific and easy to use that a user can "dial in" to a soil database and get land-use information that matches his particular needs.

However. there is a "big but" in our future expectations of the ways in which computers can assist us. The "big but" is a "big gap" in the information that has been fed into Geographic Information Systems. The "big gap" is that the expertise of the soil surveyor did not accompany his data into the computer. Without the surveyor's expertise, the computer cannot express its total capability. We are asking the computer to be a tool to help us. but we do not feed it an adequate diet--we are giving it the potatoes but "where's the beef." We must get into the computer the thought processes that are expressed in the

intensity of excitement. experience. and interpretation that occurs when a soil scientist is in a soil pit. The same applies to what happens when an expert looks at a landscape and registers in his mind its evolution and potential. That also must get into the computer. It is not easy to get this hidden information into a computer because an expert is not conscious of the working knowledge he uses everyday and forms into a pattern to suit each unique problem. We must learn to transfer the working knowledge of experts. Therefore, a fundamental issue in information technology is getting hidden expertise into computer systems. The present constraint for computer assisted land-use decision making is not indigestion from the amount of information but malnutrition for the want of the appropriate type of information.

A second issue concerns the locus of land-use decision making. Right now, institutions make the decision. The Soil Conservation Service. for instance, decides the land capability classification. But fixed land classifications limit the exploration of possibilities for different cropping systems. Fanners may be in a better position to make the most appropriate decisions, and computer technology should be able to provide the tools for a farmer to accept these responsibilities.

The possibilities of different loci of land-use decision making and a new set of decision makers having direct access to soil data raises another issue. The third issue is best expressed as the question: Are we gathering and transferring the most appropriate data? I would say that, by definition, we are not already providing the data that the new users need. This afternoon. when I address you again. I will give some examples. For instance. policymakers and regulators of pesticide usage are now users of soil data and information. We must ask whether we have the most appropriate data to present to them. When I asked myself that question, the answer I must give is a definite no.

My challenge to you is that of expanding opportunities and that these problematic issues can indeed be transformed into opportunities. By making best use of all the information and the technologies that are available to us. we can progress toward a new age for soil information transfer. But the extent to which the capabilities of the new technologies are exploited will depend upon the ability of soil scientists to deliver both their working knowledge and their data to computers. That, I believe. is the meaning of your conference theme: Working Toward Agrotechnology Transfer."

Soil Conservation Service
Office of the Assistant Chief
for the West

The National Cooperative Soil Survey remains one of the finest technical efforts by a federal, state, and local partnership. We should be proud of our achievements, and we should be aware that the importance of this effort is growing.

Right now, there's an extraordinary demand for soil survey mapping, given SCS responsibilities under the Food Security Act of 1985 (FSA).

Meanwhile, improvements in Soi 1 Survey Program delivery are underway, and we're preparing for an exciting and demanding future.

This is a good time to take stock of where we are and where we're going in the NCSS. I'd Like to give you the SCS perspective.

FSA will continue

your statesoil scientist to keep on sending this help...because I'm convinced that, down the road, this FSA effort will pay dividends. It will be worth the tradeoffs we're making now in terms of ongoing program work. Keep in mind that our success in implementing FSA has a lot to do with SCS's current support in Congress and the White House.

I believe we've fared very well-considering the tough budgeting this country has to do. For this fiscal year, Congress gave our soil, survey program \$6 million over the 1987 appropriation in support of our Farm Bill work. The budget proposal for 1989 also shows an increase to accelerate soil survey mapping for WA.

Again, I think that the people who control our budget recognize the enormous team effort to implement the FSA conservation provisions...and the demand for ongoing SCS programs. That's clear if you've taken a look at the White House proposal for our 1989 budget.

The states have done an exceptional job in using their soilsurvey resources to the fullest. Montana is a good example. Between 1985 and 1987, Montana increased its soil survey staff by 56 percent; but with that staff, they achieved a 125 percent increase in the annual mapping rate. That's a fantastic accomplishment by Montana's soilscientists! To add to this accomplishment, other states helped Montana with soil scientists on voluntary detail.

Out of the FSA workload demands and the budget constraints...and out of planning we've been doing for some time...have come efficiencies in soil survey operations and program delivery that will take us into the future.

We're centralizing our soil survey core technical leadership at Lincoln, Nebraska, where we've established the National Soil Survey

Center. The center is responsible for quality assurance. It keeps all our experts together so they can more easily, and quickly, resolve technical issues and train field staffs in proper soil survey procedure.

Soil scientists at SCS's four national technical centers have less of a review function than in previous years. They now concentrate on helping the states interpret and use soil survey Information. ..and support them in using soil survey data bases. They are your close links in NCSS for regional. activities. And they help us look down the road at future needs.

By adopting the latest technology in fieldwork and in the office, we're gearing up to meet present and future needs more efficiently. Computers in our area soil. survey offices and in our field offices, for example, provide greater flexibility in updating soils data and in meeting user's needs.

We are very anxious to bring digitizing capability to our state and field offices. Our hope is to make it part of the ongoing soil survey process; that is, to build it into the field mapping procedure. Most likely, we'll start by setting up digitizing centers in state offices, and eventually in field offices.

We want digitizing to become an integral part of our soil survey updating process. Currently, the National Office is not funding digitizing. That's up to our state offices or to any private organization that wants digitizing badly enough to pay for it. We will cooperate with any private organization and provide the digitizing standards we want followed.

We're trying to get additional funds built into the 1990 budget so that the National office can help fund the digitizing effort. If we get that money, we'll then set tire criteria for our priorities in digitizing.

This discussion of updating brings me to what I want to say about the future of our soil survey program.

Maintaining or updating existing surveys is a priority. In updating, we don't want just the same old thing. We want digitized surveys that provide --

- Consistency within their major land resource area.
- . Map unit descriptions that do a better job of characterizing the map unit in relation to the entire natural 'landscape. This will be especially helpful as districts do their conservation planning on a hydrologic unit basis.
- . And we want those digitized surveys to provide any new information required by users.

Our biggest job for the future is meeting the many diversified needs of soil survey users. Here are a few examples:

- water quality, a top priority in the USDA's National Conservation Program increases the need to understand, for example, how various insecticides, herbicides, fertilizers, municipal wastes, and other substances move through different kinds of soils. We'll have to make sure our data are technically sound for water quality uses.
- . Land evaluation and site assessment for urban as well as rural clients will be in demand. Knowing soil potential for various uses becomes critical as local communities look at farmland and wetlands preservation and other land use policies.
- . Other environmental concerns, such as understanding the effects of acid rain willdraw on our soils knowledge.
  - . Using advances In remote sensing will be critical to

specialists who correlatesoils and vegetation.

To meet the needs of the future, we have to adopt--

- . A multidisciplinary approach in our operations,
- . Interagency sharing of data and know-how, and
- . Computerized geographic information systems.

A multidisciplinary approach is absolutely essential. if you consider the complex problems soil survey users have to solve...and the interpretations we need to make with our data.

SCS DeputyChief for Technology Robert Shaw laid this kind of thinking out last year when he addressed our state conservationists about the future of technology in SCS. He foresees that "Interdisciplinary work in the soil survey program will be common. And manyspecialists other than soil scientists will. be involved and often be the leaders in specialized interpretations and research studies."

Geomorphology is one of the areas in which we'll be seeing more interdisciplinary work. SCS is now hiring for the position of national geologist. That's a position I know many of you have wanted to see filled for some time.

Interdisciplinary effort means drawing on the talents and data of other federal and state agencies, and our university cooperators. It also means greater coordination between our soil scientists and our specialists in conservation planning, resource conservation, and watershed planning.

Soon, geographic information systems (GISs) will help this interdisciplinary effort. Linked with our field office computer systems, they will provide wore flexibility and more options in conservation planning. GISs will "se modeling and applications programs; and they'll

enable us to access data from SCS, the U.S. Geological Survey, and other agencies to produce basemaps of topography, hydrography, soils, geology, cultural resources, and transportation.

SCSis proud that the Office of Management and Budget has given us the responsibility for national coordination of digitized soils data. We've earned that responsibility, with the help of our cooperators, but there's a lot we still have to do to keep on the forefront of this technology. For one thing, we should continue to pursue our 1: 250,000-scale STATSGO mapping. We're somewhat behind schedule, largely because of our FSA priority, but we must continue building this data base. It is designed to provide consistent soils information at a scale practical for statewide and multi-county applications. Agencies with GIS capability have found this compatibility useful.

Taking into the account all the diversified need for expertise in soil science and other disciplines brings up the subject of staffing.

Right now, SCS staffing needs are controlled by FSA, at least through

1989. As to 1990, we're now polling our state offices on their needs.

I can tell you right now, the need for soil scientists is increasing, not declining. In fact, I'm encouraging SCS state conservationists to maintain the soils staff they have because soil science students and graduates are getting harder to come by. That's because fewer are going into the profession...and many of those who do are attracted by the private sector's higher salaries.

SCS supports every effort by our university cooperators to update their curriculum to attract more students. We also encourage you to guide your students in the multidisciplinary studies useful to natural resource agencies like SCS. Broad, multidisciplinary training is

important in the SCS ranks as we increase our domestic and international activities.

The continuing suppport of all our NCSS cooperators is vital to the scs soil survey program. As we deal with our staffing, budget, and technical needs, SCS knows that the single most important factor in our work is the strong NCSS partnership. We thank you for your ideas and support.

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#### FOOD SECURITY ACT - PROBLEMS AND OPPORTUNITIES

James A. Carley
State Soil Scientist
USDA, Soil Conservation Service
Spokane, Washington

Never have our soil surveys been tested more than in implementing the 1985 Food Security Act. Every aspect has been tested—the surface textural phase, the soil depth and the assigned T value, **K** value. the Wind Erodibility Group, and the associated I values. Even the slope range of the map units is tested as it is a factor in determining the LS value. These erosion factors, in combination with the appropriate R value and/or Wind C value, are used in formulas to determine whether a soil map unit is Highly Erodible.

The erodibility index of a soil map unit is the basis for identifying highly erodible land. The erodibility index of a soil is determined by dividing the product of R, K, and LS by the soil loss tolerance (T) value for water erosion, and the product of I and C by the soil loss tolerance (T) for wind erosion. The T value represents the maximum annual soil erosion that could occur without causing a decline in long-tern productivity. A soil map unit with an erodibility index of 8 or more is a highly erodible map unit.

#### WATER EROSION:

The potential erodibility from sheet and rill erosion is estimated by multiplying the following factors of the Universal Soil Loss Equation (USLE):

- (1) Rainfall and runoff (R)
- (2) The susceptibility of the soil to water erosion (K).
- (3) The combined effects of slope length and slope steepness (LS).
- (4) Dividing these factors by (T).

The erodibility index is represented by the formula RKLS/T for sheet and rill erosion. A soil map unit is Highly Erodible if the RKLS/T = to or >8.

Example: R K LS /T = EI 40 \* .49 \* 2.5 /5 = 9.8EI = to or >8 = Highly Erodible map unit.

#### WIND EROSION:

Potential erodibility from wind erosion is estimated by multiplying the following factors of the Wind Erosion Equation (WEQ).

- (1) Climatic characterization of windspeed and surface soil moisture (WindC), and
- (2) The susceptibility of the soil to wind erosion (I) which is an interpretation from the Wind Erosion Group (WEG) assigned to a soil.

The erodibility index is represented by the formula CI/T for wind erosion. A soil map unit is Highly Erodible for wind erosion if the CI/T value for the soil map unit equals or exceeds 8.

Example: C = I /T = EI 50 \* 160 \* /5 = 16.0EI = to or > 8 = Highly Erodible map unit.

The accurate determination of Highly Erodible land is dependent on the accurate determination of K values, I values, T values, R values. and the accurate mapping of pet-cent of slopes and estimate of the length of slope to determine the LS value. The only factor that our soil surveys do not address is the Wind C value which is derived from sources other than the soil survey and is in the Field Office Technical Guide (FOTG).

A Highly Erodible Coil Map Unit List was developed for each county or soil survey area. The lint identifies those soil nap unit- in a county or survey area that are highly crodible from sheet and rill erosion or from winderosion.

#### SAMPLE HIGHLY EXCOURTE LAND (MOL) LIST FIELD OFFICE TECHNICAL GUIDE (FOTG)

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By calculating the minimum percent slope with the minimum length of slope and minimum R value we are able to identify the Highly Eredible (PEL) map units. Libewise by calculating the maximum, length of slope with the maximum percent slope with the maximum R value, we are able to identify the non-highly erodible (PHEL) map units. But this method developes a long list that are rotantially Highly Brodible Land (PHEL) map units. To determine if a PHEL ma unit is HEL or HHCL, the conservationist was to make a field visit to determine the LS value from field transacts. However, this is very time communing. For a particular soil, we know the following information:

- " value from soils data
- T value from soils data
- 1 R value from PPT dota (F016)

By assigning an average L5 value, we would have all of the factors needed to take a bulk determination valueby. Expendent RKES/T = 81.

In our state, we used an average "LS Value." We calculated an average LS value for each cropland map unit from the 1982 NRI data.

The 1982 NRI had recorded the percent slope and length of slope, soils series and SCS-SOI-5 record number, and land use for each point in the Primary Sample Unit (PSU). It did not identify specific map units. We accessed the NRI data base, then grouped all map units by:

- 1. Soil Series SCS-5 Record Number
- 2. Land Use
  - a. Irrigated cropland
    b. Non-irrigated cropland
    c. rangeland
    d. woodland
    e. urban
    f. other
- 3. Slope
  - a. 0-3% d. 15-30% b. 3-8% e. 30.40% f. 40+%

SAMPLE: 1982 NRI data for Average LS values

SCS Record No. WA0026 = Walla Walla Series
Slope Group = 15-30% slopes
Land Use = Non-Irrigated Cropland

OBSERV POINTS	SLOPE PERCENT	SLOPE <u>LENGTH</u>	<u>LS_VALUE</u>
1	20	375	3.89
2	23	225	3.30
3	16	390	3.42
4	18	653	4.79
5	25	275	3.82
6	28	250	3.63
			3.8 = AVERAGE LS VALUE

Using the actual measured percent slope and length of slope, the LS value was calculated. Our next step was to assign the soil scientist most familiar with the soil survey in the county to review the computer generated groupings and assign them to soil map units. This took about 4 hours per county. These values were given to the applicable FO for testing and with some minor refinement for some map units, the average-LS value was assigned to the map unit. This average LS value is used in the USLE for HEL determination, eligibility for Conservation Reserve Program, and in the Conservation Compliance planning process. This average LS has saved our state thousands of hours and, therefore, thousands of dollars in making HEL determinations and determining eligibility for the CRP.

When the average LS value is used, an EI matrix table can be generated. Following is a sample of one generated for 'Whitman County, Washington:

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From the soil map symbol and estimating the precipitation of the map unit delineation, the ST can be quickly estimated. This reduces the calculations necessary to determine if a map unit is MSL or not and is very handy for a quick reference that can be used by the technician or the factor.

#### MIGH EROSION

 $\underline{\mathbf{I}}_{\underline{\underline{A}}}^{\underline{A}}\underline{\mathbf{G}} \geq \mathbf{B} = \mathbf{H}\mathbf{M}_{\mathbf{A}}$ .

The I value is interpreted from the WSG assigned to the suclede soil desirate. Soils in MiG I have the highest I value - 160 to 310. These in WRG 8 do not have wind erosion problems and, therefore have an I value of 0.

the C value to the "Wind C." Each FO has in their Vield Office Technical Guide (FOTO) a copy of the state Wind C map. The wind "O" can range widely in some counties. In Grant County, Publishington, the Wind C charges from 130 to 170. This value is based on the combination of wind speed, desistion, and soil soluture, and is extended as a percent of a station located in Kansas which is 100 percent. Therefore, 160 is 60 percent of the wind effect that occurs at Ponsas. The T value is the same as previously discussed.

## THE WEST BOOK THE STORY OF

inighty tradition and classes: I will oblive February Cant 2 — Patronization in progressional 3 — Not Highly tradition

County band & Values: No. 1889 0.21 6.70

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EI matrix can also be developed for Wind Erosion. The range of Wind C for a county can be determined from the map. Estimating the Wind C for a field and knowing the "I" value of the map unit, the EI can readily be determined.

However, it is difficult to determine if a soil is consistently NEL due to wind. Some soils mapped in Washington occur in areas of Wind C value ranging from .15 to .70. Therefore, it is NHEL or NEL due to wind depending on the Wind C value..

SAMPLE EI MATRIX TABLE - WIND EROSION

County Wind C .45 - .70

WIND C VALUE

				WEG	1: VALUE	.45	.50	.55	.60	.65	.70	•
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I	I	ţ				<	<b>E</b> R	OSION	INDEX	EI	>	1
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SQUATZEL	FSL	609	5	3	86	7.71	8.6	9.46)	10.31	11.21	12.01	
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SQUATZEL	SIL	14271	5	5	56	5.01	5.6	6.161	6.721	7.281	7.841	•
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A Highly Erodible Land (HEL) Worksheet was developed to use in the state. This worksheet provides a record of the map units by field to determine if the field is Highly erodible. The information from the Highly Erodible Land list or the EI matrix tables is posted on this worksheet. The acreages of Highly Erodible map units in the field are summated. A field is Highly Erodible if it has 50 acres or more or 33 percent or more highly erodible soils in the field. The worksheet also aids one in determining the EI for planning or eligibility for Conservation Reserve Program.

SAMPLE: HIGHLY ERODIBLE LAND WORKSHEET

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Now, we have really put our soil surveys to a test. This is particularly true of the soil surveys that ace 20, 30, and 40 years old. Commonly, slope groups have been mapped too wide. Map units that have 0 to 30 percent slopes are common in some of our older reports. The 0 percent could be on the top on a narrow ridge, but the main part of the land form could have slopes of 15 to 30 We have many soils with varying degrees of cementation or induration within the same map unit and the assignment of T values, based on renewable or non-renewable material, is often not possible. We have soil surveys where the surface textures do not join at the county lines. A particular case has silt loam with an I value of 56 in one county and across the county line the same series is mapped with a very fine sandy loam and an I value of 86. is just right so that the I of 56 is not Highly Erodible and the soil with I of 86 is Highly Erodible. In one county, we have eroded phases of map units and yet the K, T, etc. are the same as the non-eroded map units. The yields are substantially less and residues are less. Since the K, T, R, and LS are the same, the EI for the eroded map units are the same as the non-eroded. Many soils are mapped in too wide of precipitation zones. There are soil taxonomic differences that are reflected in the soils that were not considered in mapping. We need better criteria and guidelines in assigning I values for There is a tremendous need for Major Land Resource Area soils. re-correlation. some remapping and updating of interpretations for more accurate application in the FSA. But, we might be too late---. We have about 700,000 acres of cropland left to nap in the state of Washington by January 1, Budgets for this work are stretched. Soil Scientists available for hire or detail are few. Our field soil scientist are being "burned out" to accomplish the task at hand. Farmers often are requesting reconsideration of the soil survey when they are not qualified for CRP. Others are requesting reconsideration of the soil survey when they learn they have fields that are

HEL. Sodbuster and Swampbuster are priority work in the FSA. Where we do not have a soil survey available and sodbuster is being considered, the District Conservationist can make the HEL determinations. However, many have little training in soils and are not competent to make this resource base decision and, therefore, are calling in soil scientists to make the survey. This interrupts mapping progress in project soil surveys.

The installation of CAMPS and the soil survey data base to the Field Offices has been helpful. Because of the revisions and updating of older SCS-5's for use in the project soil surveys, it is difficult to keep the county data bases up to date. Having a soil survey data base in each county is a major step forward. I'm proud of the work that has been done by soil scientists over the years in our state and how well the surveys are serving their need and purpose. We have all had to be very innovative in the use of funds, staff, and soil survey techniques in our effort to complete the cropland for the FSA. We need to exchange ideas between states and techniques that are working to accelerate mapping. Our soil surveys are being used!! As managers in the NCSS, it is our job to insure a quality soil survey under the accelerated soil survey program. Finding that balance is our challenge.

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#### THE ROLE OF THE NATIONAL OFFICE IN THE REORGANIZATION OF THE SOIL SURVEY

#### Richard W Arnold Soil Conservation Service

#### INTRODUCTION

Remember when we had the four soil-geomorphology projects? That was a time of building concepts, developing models. collecting data, studying field techniques and being involved in training. It was a period of excitement, of discovery, and intense activity. Great. really great.

What are we doing today to fill our storehouse of knowledge that will carry us another 25 years? Yes, yes, I know, the computers, GIS, CAMPS, EPIC! FOCAS MODULES, GEOSTATISTICS, FSA, and on and on...these are all keeping us very busy and over occupied.

Where are we getting the data that are required for these sophisticated activities? We are the soil scientists, it is up to us. Are we doing it? I fear that we are far short of where we ought to be.

Budgets, personnel prohlenrs, shifts of emphasis, shortage of trained and available soil scientists - nobody has escaped the problems. Each of you has been trapped or stymied to some extent by the circumstances. Is there a way out? Of course there is. The path may not be very clear, but the goal of "pedologic excellence' keeps us together and motivates us to forge ahead. Our storehouse Is low and if we don't fill it, others may take over the granary.

#### ROADSIGNS OF PROGRESS

In 1980-81 members of the Grace Commission studied government and how it might be made more effective and what could be done outside of govern-Soil survey was one of the USDA programs that was examined. It seemed an imposition to have people look so close at our operations but they did it anyway. Soil survey was chided for being overly accurate with its edited manuscripts and for overmanaging that effort. We were told that CASPUSS was not an effective management tool and that we needed a better one. It was suggested that some off-the-shelf software might work but as we found out soil survey is more complicated than that. They also thought we should charge for the soil survey reports. We responded to these and a few more suggestions. We defended successfully the "no charge" policy because of the large and varied Input of the cooperators of the NCSS and it would be unfair to double charge. We started with new initiatives including a redirection of \$7 million over a 6-7 year period because no additional funds were available. The editing process was modified and other management initiatives to make soil surveys track along more smoothly were Implemented.

Then in 1983-84 the SCS Program Evaluation Team developed a strategy to look at the \$011 survey and how it operated as the NCSS. The main emphasis was on SCS activities but it did include what cooperators and

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users of the information thought about the products and services. Many of you were participants in interviews, questionnaires or follow up on the tracking of what had happened to surveys as of 1983. It became apparent that we still took a long time to get some of the reports published and that there were places where we should target effort. We had some insight into the overlap of functions of state and regional staffs. We became more aware of users' needs and that although we were goad, we weren't without fault. By the time the report was accepted and published we had implemented most of the suggested changes. We no longer made "well visits" to look at programs, rather IP concentrated where you said you needed help with reviewing and analyzing the operational and budget aspects of your programs.

In 1986-87 the Productivity Improvement Program (PIP) team undertook a study of the soil survey program. Wow — a third in-depth look at who we are, what we do, and how we do it. This time the focus was on our mission and the functions we carry out. They clarified that we still could do more to become efficient and effective in our program delivery. They outlined, and in some cases detailed, ways that they felt we could gain 20% efficiency. This meant that we would have to restructure ourselves, shift some authorities and responsibilities, look at the consequences of the future and get on with it. Their report was accepted in principle by the top staff of \$C\$ and we were instructed to begin to implement many of the recommendations. The main aspects of this have been:

- The National Soil Survey Center was established
- $\mbox{-}$  a major role of NSSC is quality assurance, training, and restocking the warehouse
- The National Technical Center Soil Staff (Interpretations) was assigned the function of liaison with other technical staffs at the NTCs, helping coordinate interpretations and assist states as needed with GIS and other aspects of using soil survey information. They were to retafn the lead role of regional interaction among cooperators.
- States were re-assigned the quality control function and the major role in carrying out the soil survey.
- The National Headquarters was to be the operational provider and general overseer.

#### TODAY'S OUTLOOK

I know that some of you feel that we haven't kept you informed very well. I apologize for any misunderstanding that has arisen. We have had to move cautiously up to now but please rest assured that NCSS has always been well represented in deliberations and the actions that have been taken.

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These three in-depth reviews of the soil survey have actually provided the information and knowledge that have led us to the exciting places we are at the present time. Because we know a lot about ourselves We are in a good position to strategize where and how to proceed to produce the products and services we are famous for.

In 1986 the Food Security Act started slowly but in 1987 the necessary activities started to "eat our lunch" so to speak. The time schedule and the needed information are dictating what we do, how we do it, and when we do it. We are mapping all of the cropland not just that with HEL and are remapping cropland where it is needed to determine eligibility. We are counting acres... those acres that pertain to the FSR. When that is completed there will still be the remaining lends to map and then will come water quality and other environmental concerns, The message to the NCSS Is clear, They want us and they need us to assist in many, many aspect. 5 of what's going un.

Our storehouse of soils information and knowledge to meet these challenges really deserves our best effort and attention. We want to refill the granary with good grain. We are going to be the best National Cooperative Soil Survey we can be. and that is the best In the world.

But leadership has a price, doesn't it? There are always others willing to take over that world leadership so we have to be at the cutting edge yet maintain our valuable traditions and skills and experience.

The National Headquarters is there to listen, to help, and to suggest. We are responsible for policy recommendations and also for budget initiatives and allowances. If we are to succeed, you will have to keep us informed, maybe even prodded from time to time. Through the efforts of all of us in the Cooperative Soil Survey we will provide services and goods of which we all can be justifiable proud.

#### ROLE OF THE NATIONAL SOIL SURVEY CENTER

#### Rodney F. Harner National Leader, Soil Survey Quality Assurance

The National Soil Survey Center is part of the Midwest National Technical Center (NTC). NTCs are the centers of technical excellence which provide essential support to National Headquarters (NHO) and provide leadership for technical quality assurance in all Soil Conservation Service (SCS) activities. The role of each NTC is to acquire, develop, and disseminate technical information, to provide training on technical standards and procedures, and to ensure that technical information and procedures are properly used. The NTCs help ensure that states have full technical capability for carrying out program functions. The state conservationists (STCs) are responsible for quality control; the NTCs are responsible for providing quality assurance. Quality assurance is the function of providing STCs and their staffs with the knowledge, technology, standards, procedures, and technical assistance needed to perform their quality control responsibilities. The function includes conducting technical appraisals, workshops, and training sessions; providing research reports, technical notes, and reviews of program and project proposals and plans; directing technical assistance to state staffs; and concurring in state-issued technical materials.

The following functions are performed by the NTC:

- 1. Technical quality assurance is the function of working with the STCs to assure that the STCs and their staffs have the knowledge, technology, information, standards, procedures, and processes necessary to perform technical functions and technical quality control, which are the responsibilities of each STC. Technical quality assurance is accomplished primarily through state technical appraisals, through reviews of project proposals and plans and technical materials, and through communication with appropriate state staff. The NTC quality assurance function does not include program management and administrative matters which are reserved for NHQ.
- 2. <u>Technology transfer</u> is the function of acquiring, developing, repackaging, and disseminating information to state and NHQ staffs regarding existing and new technology. This function includes technical procedures and processes, the use of technical computer software and specialized technical equipment and instruments, and the development of SCS technical guides and other technical information. This is primarily accomplished by conducting technical workshops and training sessions, preparing and distributing technical notes and newsletters, reviewing and distributing research and development reports, and by offering direct technical assistance.
- 3. <u>Technology development</u> is the function of developing new technical standards, procedures and processes, new equipment and instruments, and new computer software programs for use by state and field office staffs. It includes trial, use, and evaluation of new technology; adaptation of research and development by others to meet SCS needs; and assistance to NHQ on task forces, committees, and working groups in developing servicewide technical software, standards, and policies. This function is

accomplished in close coordination with NHQ and in some instances only at the request of NHQ in order to avoid duplication of research and development, efforts by other SCS offices, the Agricultural Research Service, other Federal agencies, universities, and by the private sector.

- 4. <u>Technical assistance</u> is the function of providing technical information through direct communication and personal visits, usually at the request of the state staff. This includes participation in state technical meetings, technical assistance in planning, design, and installation of conservation practices and major works of improvements; and discussions of SCS technical policies, standards, and procedures.
- 5. <u>Technical services</u> is the function of providing the states with such things as maps from the National Cartographic Center, engineering designs drawings from the Engineering Staff, water supply forecasts from the Water Supply Forecasting Staff, and soil laboratory testing and analysis from the National Soil Survey Laboratory. Other technical services are also provided to states when state expertise is limited or the task is beyond the scope of the state staff.
- 6. <u>Technical coordination</u> is the function of correlating technical matters within and among NTC service areas to ensure consistency and uniformity in applying technical standards and procedures.

The National Soil Survey Center will consist of five sections; Soil Survey Quality Assurance, Soil Classification, Soil Survey Interpretations, Soil Survey Data Bases, and Soil Survey Investigations. Soil survey quality assurance will be carried out through the following functions:

FUNCTION: Review memorandum of understanding.

#### Emphasis Items

- Purpose of the soil survey
- Guidance on soil survey procedures
- Average size of management unit
- Maximum size of contrasting inclusions
- Map scale
- Schedule for completion

FUNCTION: Participate in initial field review or early progress review.

#### Emphasis Items

- Design and description of map units
- Naming of map units
- Classification and description of taxonomic units

- Documentation
- Map quality
- Quality control procedures
- Accuracy of interpretations
- Adequacy of special investigations and laboratory data
- Staffing and management
- Use of special symbols
- Matching of maps with adjoining soil surveys

#### FUNCTION: Review field review reports.

#### Emphasis Items

- Quality control procedures
- Staffing and management
- Legend control
- Naming of map units

#### FUNCTION: Participate in final field review.

#### EmpHasis tems

- Description of map units
- Naming of map units
- Classification and description of taxonomic units
- Documentation
- Detailed map quality
- General soil map quality
- Accuracy of interpretations
- Adequacy of special investigations
- Status of soil interpretation records
- Classification and use of laboratory data
- Status of manuscript
- Matching of maps with adjoining soil surveys

FUNCTION: Review of draft of final correlation,

#### Emphasis Items

- Naming of map units
- Problems and deficiencies noted at final field review

#### FUNCTION: Training.

#### <u>Emphasis Items</u>

- Basic soil survey course
- Soil correlation course
- Workshops for state soils staffs
- Participation in state workshops
- Training of individuals
- Training during field reviews
- Development of training aids and modules

The emphasis is on progressive soil correlation. During each field review the taxonomic units and map units recognized since the last review need to be reviewed and approved. With progressive correlation map compilation and development of the soil survey manuscript can keep pace with correlation.

The National Soil Survey Quality Assurance Staff will make its input early in the survey, beginning with a critical review of the memorandum of understanding. Assignments will be on an MLRA basis. A soil scientist will be assigned to a soil survey to follow it from development of the memorandum of understanding through correlation. It is essential that staff members participate in the initial field review or an early progress review.

### NATO SOIL INTERPRETATION STAFF MISSION, FUNCTION, STAFF

#### MISSION

In provide regional assistance, coordination, and technology development and transfer in the areas of soil interpretations, GIS and remote sensing.

#### FORCT FONS

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- 1. Arovide leadership in the coordination and consistency of soil interpretations by Pajor Land Resource Areas.
- 2. Provide equility assurance and coordination of 18.8A maps.
- 3. Provide soils input as part of the multidiscipline NIC quality assurance for program activities.
- 4. Integrate solls information with other discipline activities.
- 5. Assist the National Soil Technology staff with the development of the criteria and methods for the interpretation of soils.
- 6. Furnish technical assistance and guidance in collecting and summarizing available knowledge about soils and their behavior.
- 7. Assist in the development, improvement and use of soil and other geographic data bases.
- 8. Assist in the development, improvement and use of soil tabular data bases.
- Provide assistance in the analysis and interpretation of soil performance for expanded use of soil survey data.
- 10. Provide assistance for more effective use of soils information.
- 11. Serve as fraction with cooperators of the National Cooperative Soil Survey.
- 12. Assist in the transfer of research and technology.

#### The mission and function of the WNTC soils staff

Considering the consolidation of many technical functions of soils program from the NTC and NNQ to Lincoln, Nebraska, you may be surprised that a soils staff exists at the NNTC. The NNTC soils staff has changed its role with this consolidation of functions. I am here to explain this new role.

The soils PIP study, which recommended the consolidation, concentrated on the production part of soil surveys. It did not recommend a role to the NTC soils staff. During the time of that study, however, the NTC's were proposed for consolidation as well.

In defining the role of the NTC soils staff, it should first

#### INTRO INTO SLIDI'S

TO EMPHASIZE THE COMPUBLICATION ASPECTS OF SOILS WORK ALLOW HE TO PRESENT THE FOLLOWING SLIDES;

SOIL IS A VARUABLE RESCURCE I KNOW WE SHARD THIS PRELIMC! I DON'T KNOW IF WE SHARE THE PERSONS ON PUTTING A SOIL

SURVEY TO USE.

TO ILLUSTRATE BY FEELINGS LET HE COMPART A SOIL SURVEY

TO THE PROPUCTION OF AN AGRICUATURAL PRODUCT

A SOIL SURVEY BEGINS WITH PREMAPPING, A STEREO VIEW COMBINED WITH VARIOUS RESOURCE DATA AND TOEG, MAPS PROVIDE THE SOIL SONT, WITH THE PRELIMINARY MAP

A CROP MAY BEGIN WITH THE FIRST CUITIVATION

AS A SOIL SURVEY PROCHEDS THROUGH TRANSECTS

TRAVERSES

DESCRIPTIONS

INVESTIGATIONS

OBSERVATIONS

SLOPE DETERMINATIONS

AND PROGRESS REVIEWS

A CROP PROCEEDS THROUGH PLANTING, FERTILIZATION

CULTIVATION

IRRIGATION

HARVESTING

THE SOIL SURVEY PRODUCES SOIL MAPS AS PART OF THE SOILS HANDBOOK

THE AGRICULTURAL OPERATIONS PRODUCE A RAW PRODUCT AS WELL. BOTH THE SOIL HANDBOCK AND RAW AC PRODUCT ARE USEABLE BUT THEY ARE NOT READY FOR THE FINAL MARKET

THE HANDBOOK PROCEEDS WITH TECHNICAL REVIEW AND EDITING

COMPILATION AND DIGITIZING

AND MAP PRINTING

THE HARVESTED CROP PROCEEDS DOWN THE ROAD

FOR PROCESSING AND PACKAGING

THE FRODUCT OF THE SOIL SURVEY PROCESSING IS A PUBLISHED SOIL SURVEY

THE FRODUCT OF THE FOOD PROCESSING IS A PRODUCT SIMILAR IX THAT IT IS READY FOR PUBLIC CONSUMPTION

FROM HERE THE FOOD INDUSTRY DEVIATES AND DOES NOT LEAVE THEIR PRODUCT ON THE SHELF

THEY ADVERTISE

AND PROMOTI: THEIR PRODUCT

THEY WORK WITH USER SPECIALISTS IN DEVILOPING AND DISTRIBUTING NOW TO MANUALS LIKE COCK BOOKS

TO TELL YOU HOW TO FRY 11

IN A VARIETY OF VAYS

OR MICROWAVE IT AS HOHE TECHNOLOGY CHANGES

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EXPANSION INTO NEW MARKETS AND USER GROUPS IS A CONSTANT EFFORT

BECAUSE THROUGH EXPANDED USE; COMES THE MOTIVE AND THE REAL PRODUCT "\$\$\$\$\$" FOR PRIVATE INDUSTRY

THROUGH EXPANDED USE OF THE SOIL SURVEY THE MOTIVES OF THE SOIL CONSERVATION SERVICE IS REALIZED

I T IS FOR THESE CONSERVATION MOTIVES THAT THE APPLICATION, IMPROVEMENT AND EXPANSION OF SOIL INFORMATION BECAMP THE FOCAS OF THE SOIL INTERPRETATION STAFF

IT IS CUR GOAL TO ASSIST YOU IN TAKING THE SOIL SURVEYS OFF THE STIELL! AND MAKE THEN HORE ACCESSIBLE AND ADJUSTABLE THROUGH EXPANDED USE OF THE DATA BASE

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SOILS INFORMATION VILL BE IMPROVED BY GATHERING ADDITIONAL DATA

PY TAMER A DROADER PLESPECTIVE PLREAPS THROUGH NEW YOOLS SECH AS REMOTE SPESING IS PROVIDING.

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BY MORKING TOGETHER ME CAN IMPROVE OUR CLASSIFICATION AND JUTERPRETATION STAPBARDS

A FUNCTION OF THE NTC SOILS STAFF WILL BE TO WORK CLOSER WITHOTHER DISCIPLINES TO FULLY INTEGRATE SOILS INTO THOSE AREAS

RANGE LAND IN THE U.S. OR

IN DRYER PARTS OF THE WORLD

CAN BENEFI T FROM UNDERSTANDING THE SOIL RESOURCE

RECREATIONAL ACTIVITIES THAT AFFECT OUR FAMILIES

OR OURSELVES CAN BENEFIT

WILDLIFE

FROM OUR MITLANDS NELD IDENTIFICATION AND PROTECTION OF HABITATS

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MAY BE FRACILE

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BUT OF HAVE ONLY BECUV A LONG JOURNEY ONCE THE SOLL SURVEY IS COMPLETE

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LETS RIMFHREE TO "CONSIDER THE SOIL FIRST"

The Food security act put more in service emphasis on the soil survey than any  $\,$ 

To be clearer let me state that:

The mission of the WMTC soil interpretation staff is to provide regional assistance, coordination, technology development and transfer in the areas of soil interpretations, GIS and lemote sensing.

In light of this mission the following functions have been accessed:

- 1. Provide leadership in the coordination and consistency of soil interpretations by Major Land Resource Areas.
- 2. Provide quality assurance and coordination of MLRA maps.
- 3. Provide soils input as part of the multidiscipline MTC quality assurance for program activities.
- 4. Integrate soils information with other discipline activities.
- 5. Assist the National Soil Technology staff with the development of the criteria and methods for the interpretation of soils.
- 6. Furnish technical assistance and guidance in collecting and summarizing available knowledge about soils and their behavior.
- 7. Assist in the development, improvement and use of soil and other geographic data bases.
- 8. Assist in the development, improvement and use of soil tabular data bases.
- 9. Provide assistance in the analysis and interpretation of soil performance for expanded use of soil survey data.
- 10. Provide assistance for more effective use of soils information.
- 11. Serve as liaison with cooperators of the Rational Cooperative Soil Survey.
  - Assist in the transfer of research and technology.

We currently have a staff of five soil scientists and one secretary. One of these five positions however is pending disability retirement and will be replaced with a GIS remote sensing specialist this fall.

Each staff member has a primary responsibility to:

- (1)provide technical leadership and assistance to states
- (2)provide technology development in an area of expertise
- (3) assist in technology transfer

We hope to serve your needs. In order for me to get a handle on your states activities please don't hesitate to invite me to your work planning conference or similar function. Please include us in reviewing your lab plans, perhaps lab data could assist in interpretations not just classification. MOU's should include interpretations----let us assist you---

Presented to the West Region Soil Survey Work Planning Conference, June 13, 1988 by Gary Muckel

Western Regional Soil Survey Work Planning Conference Kahului, Maui, Hawaii June 12-17, 1988

Cartographic Support for the NCSS Richard Folsche Head, NCC USDA-SCS, Fort Worth, Texas

#### ORGANIZATION CHART - Handout

NAPP Replaces NHAP. Scale 1:40,000

1 Is being flown for quarter quards.

Scale of the future. 1:24,000 and 1:12,000.

Five-year plan — if state is not flown in year scheduled, must wait 5 years. Map and write-up handout.

Federal government is asking for state government 50-50 cost sharing to Insure state priority.

NCSS - 80 publications/year

 $120\ counties$  of completed maps received by NCC per year

STATSGO Status (handdout)

SURGO Status - Western states leading way (handout)

COLOR COPIER - Slides, maps, etc. - Vugraph -copies of products

handed out.

material, both edit and layout.

GIS - GRASS - ARC/INFO - COURSES will be given monthly by NCC on GIS

NCC expects GRASS to be accepted and

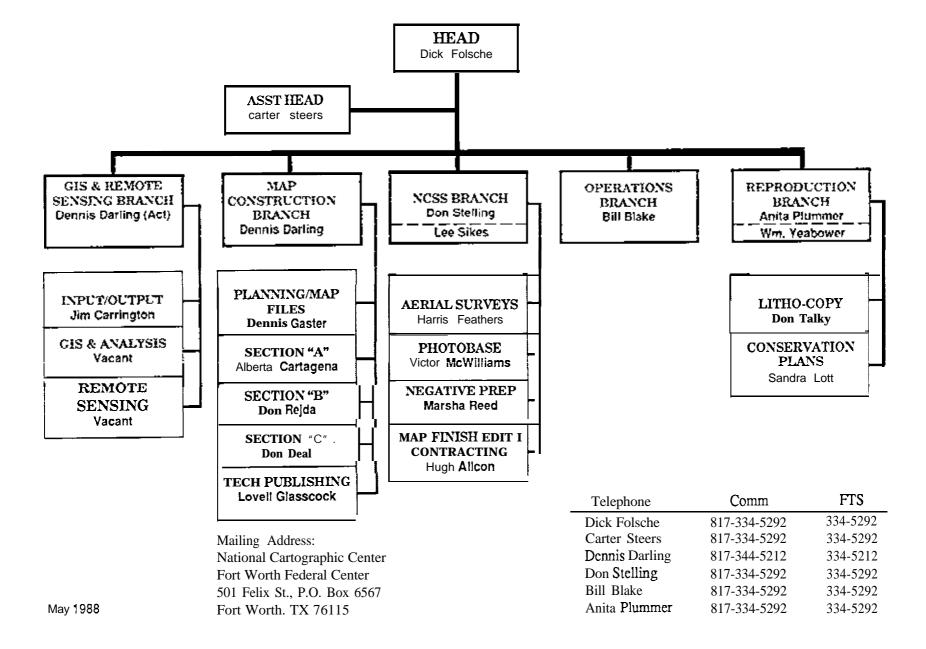
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will be given, starting in mid-

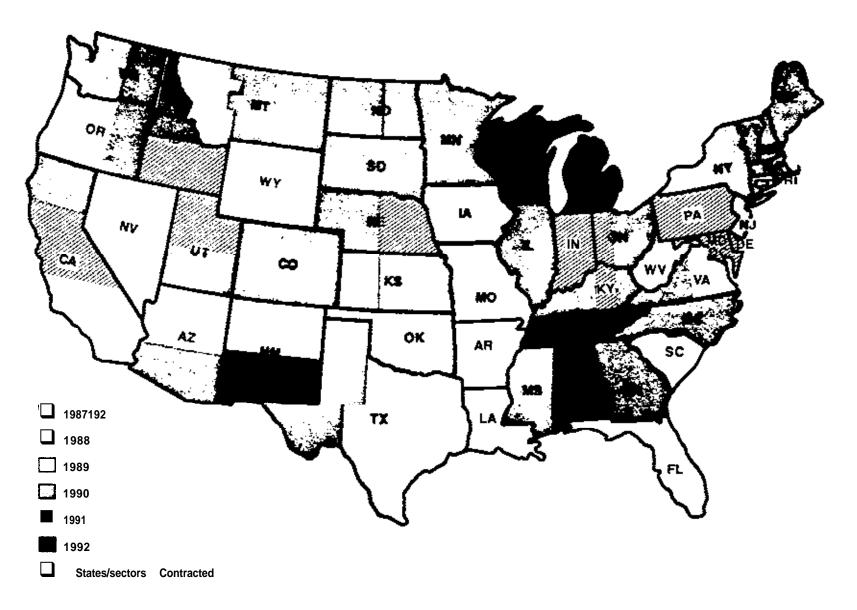
summer.

MAP FINISHING - CONTRACTING - DIGITIZING BY CONTRACT - handout.

## **NationalCartographic Center**



## MULTI-YEAR NATIONAL AERIAL PHOTOGRAPHY PROGRAM (NAPP) ACQUISITION PLAN



Soil Conservation Service

# REPORT ON MAP FINISH CONTRACTING NATIONAL CARTOGRAPHIC CENTER FORT WORTH, TEXAS

This report describes work that has been performed by the National Cartographic Center since June 1985, for NCSS map finish scribing. Seventeen states have participated in contracting for map finishing services through the NCC. Fifty-two survey areas have been contracted totaling 2,684 map sheets of which 407 of the map sheets were full quad format. Total contract cost for these 52 surveys is \$355,929.58 or an average of \$6,844.72 per survey area. The average for map sheet is \$132.61. The cost range is \$53.44 per map sheet to as much as \$529.37 per map sheet. The higher price range was for highly detailed soils and culture on a full quad format.

Most of the compilation received from the states is quite adequate for contract map finishing. Some is very well done, while others are poorly done and/or contain excessive errors. We can usually correct errors, missing symbols, soil lines, etc. by referring to the field sheets. However, poor quality work cannot be corrected efficiently. The poor quality compilation usually produces poorer quality maps at a higher cost. We pay contractors \$2.00 each for authors errors.

#### OUR ROLE IN THE PACIFIC

The Soil Conservation Service has been active in the Pacific Basin since 1978 when we started the re-imburseable soil survey of Ponape. Kosrae, Truk, Yap, Palau and the Marshall Islands. scs, in cooperation with the Forest Service, University of Hawaii, and the Trust Territory of the Pacific Islands, assigned two soil scientists, Chris Smith and Bill Laird, to Ponape, completed the field work in 1980, and published the soil survey reports in 1982.

In 1981, American Samoa also requested a soil survey. Two soil scientists from New Mexico, Chavez and Roybal, spent 3 months and completed the field work. The soil survey report was published in 1984.

The Guam soil survey was started in 1983 with the transfer of Fred Young to Guam. Major field work was completed in 1986 and the report published in 1988.

The CNMI survey was started in 1985 when Dean Burkett and Terry Huff from California were detailed there for two months. Publication is scheduled for January 1989.

The publication for the Marshall Islands is also scheduled sometime in 1989.

With the publication of these islands, SCS will have mapped all of the islands controlled by the United States except for small islands and restricted islands such as Bikini, Enewitok, etc.

SCS has been taking on greater responsibilities in the Pacific. We have a field office in Mangilao, Guam with Joan Perry as Assistant State Conservationist, Lauie Ho, DC and a staff of 3 others.

In Saipan, we have Charlie Frear, DC and a staff in Rota and Tinian.

Over in American Samoa, Calvin Harada works with a conservation aid.

With this staff and assistance from the state office, we are working closely with the governments of Palau. Ponape, Yap, Truk, Kosrae and Marshall Islands officials.

Our role is to provide the people of the Pacific with all the technical assistance available through the Department of Agriculture - Riverbasin, Watershed Protection, RC&D and ACP in addition to our regular conservation operations.

Just recently, we have worked together with the ASCS to introduce the ACP program to Guam and CNMI.

In Ponape, we are working with the government to replace the presently used fern stumps with a more permanent pole for the black peeper plants.

Flood control and irrigation plans are under way in Guam and in Saipan.

In Yap, we are working with the forester to identify soils in the agroforestry plots.

Grass plots will be set up in Palau and Guam. The archeologists have requested assistance in holding a soils workshop for them.

Because of the limited land area and a tremendous growth in urbanization, the governments of Guam and Saipan need assistance in identifying the "prime" agricultural lands; areas with flood hazards or any other kind of problems or hazards. We feel that GIS will be of great help in this area.

Our role in the Pacific, is to increase our technical assistance in conservation planning.

Richard N. Duncan State Conservationist Hawaii

#### THE PACIFIC BASIN'S APPROACH TO LAND-USE DECISION MAKING\*

by

N. P. Kefford Dean and Director

# College of Tropical Agriculture and Human Resources University of Hawaii

Presented to the Western Regional Soil Survey Work Planning Conference

June 13. 1988

Maui. Hawaii

When I spoke earlier today, I challenged you to address five issues:

- 1. How to take advantage of opportunities in modern technology.
- 2. How to set research priorities based upon these opportunities.
- 3. How to use the hidden, working knowledge of experts in information transfer systems.
- 4. How to adapt to new loci for land-use decision making and new types of decision makers who use soil data directly.
- 5. How to gather and transfer the types of data and information that the new users of soil data **must** have to address their specific problems.

I trust that you will keep these issues prominently in mind throughout this working conference.

I now want to describe how we are attempting to keep these issues in mind in the Pacific Basin. I will concentrate on what is happening most directly in Hawaii while other speakers on this panel will have messages relating to the Pacific Basin as a region. Therefore, I am providing examples of the ways in which we in Hawaii are striving to practice what we preach on land-use decision making.

As far as I know. Hawaii is the only state attempting to use the Land Evaluation and Site Assessment (LESA) process for comprehensive, statewide. land-use planning. How did this come about? Every ten years Hawaii holds a constitutional convention, and the 1978 convention gave great importance to the preservation of Important Agricultural Lands (IAL). To address this issue. the convention called for the establishment of a Land Evaluation and Site Assessment Commission and charged it to develop a process for designating IAL based upon the acreages needed for specific crops into the future. The commission's charge placed extraordinary demands on the land-use decision making capabilities of the time. The general LESA process developed by the

<sup>\*</sup>This paper is **based** on the ideas and experience of Dr. Russell Yost, Department of Agronomy and Soil Science, College of Tropical Agriculture and Human Resources.

Soil Conservation Service was adopted by the commission. The soil and other land-based data available in Hawaii could be used for the land evaluation portion of the process. But. site assessment required that social. economic. geographic, historical, cultural. political, and other factors be incorporated into the system. Thus. only a multidisciplinary approach to LESA would work.

The charge given to the commission also made tough demands on the available technology. The charge required that precise boundaries of the IAL be drawn on each island such that the property of one person was within the boundary and that of another person was outside. districting in Hawaii causes all lands not designated as urban or conservation to be placed in the agricultural district. To accommodate the projected needs of crops in the future. a much smaller area was needed for IAL, but much stricter rules would apply to the removal of The Land Evaluation and Site Assessment lands from the IAL district. Commission proposed a process; but. as expected, there was no smooth sailing through the public and legislative waters. One problem was the perceived bias toward agriculture which the charge from the constitutional convention placed on the commission. The developers asked, why not a LESA process based on urban. industrial. and resort needs? As you know, LESA can be applied to any land use for which requirements can be specified. At this point in the progress toward an acceptable LESA process, the state administration changed. The new administration had great concern for land-use decision making of all So it has requested a process that can be applied to all land uses: urban. industrial, resort, and conservation, in addition to agriculture. This is a great challenge and an enormous opportunity. Fortunately, I believe that in Hawaii we have the technology that can rise to the occasion. We call this technology the Hawaii Natural Resource Information System--HNRIS. This system will be described by Dr. Akram Khan later in the conference. HNRIS coordinates many natural resource information bases, so that data from many sources can be applied to decision making. HNRIS therefore offers a multidisciplinary approach for land-use decision making. Already, HNRIS can designate boundaries for the land evaluation portion of LESA. The data for site assessment are now being fed into the computer. Very soon HNRIS will be able to combine the LESA factors to designate the IAL which will preserve the acreages necessary on each island to produce the crops that will be needed to maintain the contribution of agriculture to Hawaii's economy into the future. In addition to IAL that can be designated by a standard, soil-based, land-evaluation formula. we have some special crops whose particular requirements cannot be embraced by the formula. One of these is the only coffee grown in USA. which grows in a unique climate on the west side of the island of Hawaii. Soil is not the critical factor in the coffee zone; the uniqueness of the zone is its HNRIS is able to provide a physical description of the climatic factors that differentiate the coffee growing zone from any other area in the state. Taro and lotus root also are special crops.

Their environment can be preserved by including the taxonomic classifications of our wet lowland soils within the descriptions of the designated IAL.

HNRIS is also being used to make regulatory action more reliable in terms of pesticide hazard assessment. For this function, we find that nontraditional types of soil and other data must be collected to drive the pesticide hazard assessment model which is expressed through HNRIS. That is, the data collected for the purpose of soil classification and land capability is inadequate for writing and enforcing pesticide regulations.

Another area in which Hawaii is active is in expert systems for crop management. As you know. success in agriculture requires that the management system achieves an optimal match between a crop and its physical, biological, and socio-economic environments. Therefore, a multidisciplinary approach is essential to the development of a cropmanagement, expert system. It follows that we must have soil data and information (including the hidden expertise of soil scientists) to merge with crop, disease. pest, economic and other data to produce an expert system. For example, our college has a papaya, crop-management. expert system in which soil and plant nutrition information must merge with information on insect pasts, diseases. and weeds to produce expert outputs on yields and economics. We also have a soil-acidity, expert system. which must apply to all crops and must match the characteristics of each specific crop with soil properties. Again, we find that we have not been gathering the most appropriate soil data for the worthy objective of being able to predict the outcomes of options among crop management practices. Dr. Russell Yost will give details of our progress on developing expert systems when he speaks to you later in the conference.

Hawaii is pleased to provide coordination for a worldwide project known by its acronym IBSNAT. which is derived from International Benchmark Sites Networks for Agrotechnology Transfer. This project had its origins in the matching of soil classification with crop performance. but is now able to expand its scope into other disciplines. IBSNAT continues to be a big user of soil data snd information, but it also is now finding that different soil data, from that needed for soil classification, is needed to drive the simulation models which are the heart of IBSNAT. Later. you will be hearing from Dr. Gordon Tsuji. who will describe the IBSNAT program in detail.

How then are these Hawaii-based activities being related to the Pacific Basin7 I will provide one example. A subsystem of IBSNAT is OBSNAT--Oceania Benchmark Sites Network for Agrotechnology Transfer. The Pacific has preliminary soil data that is good. relative to the rest of the world. This data has been gathered by soil scientists from Australia. New Zealand. USA. France, and Britain. There are some major

gaps in the data such as from Western Samoa. But. a greater need is for data coordination and organization. Data collection on Pacific soils must be coordinated. and existing and new data must be organized in a manner that meets user's needs. In addition, gaps in the distribution of the major soils must be defined and filled.

This summary of work occurring in Hawaii and the Pacific Basin shows that the issues of soil survey, land classification, and land-use decision making, which I defined earlier, can be addressed. Our experience also shows that, as these issues are addressed. new opportunities for research and agrotechnology transfer are opened up. Furthermore. attention to these issues by soil scientists causes them to adopt new mind-sets. outlooks and approaches. which are as important in the new era of land-use management as bigger computers and fancy software.

We find that the incentives for soil scientists to seek new opportunities through new avenues of thinking and the use of computers are:

- 1. the effective discharge of their responsibilities as scientists. public servants. and land users;
- 2. the more appropriate and wiser use of land resources; and
- 3. the transfer of the best soil information to users so that they can make wise land-use decisions.

The bottom line for the Pacific Basin is that the land-use problems are large and diverse and little time is available to find solutions, so we are grateful that new technologies are available and that soil scientists are able and willing to pursue the opportunities for problem solving offered by the new technologies.

ROLE OF THE USDA FOREST SERVICE IN TROPICAL. PACIFIC ISLANDS FORESTRY
West Technical Soil Survey Work Planning Conference
June 13-17, 1988

Ronald E. Stewart

Director. Pacific Southwest Forest and Range Experiment Station USDA Forest Service, Berkeley. CA

Paul G. Scowcroft

Research Forester, Pacific Southwest Forest and Range Experiment Station USDA Forest Service, Honolulu, HI

#### INTRODUCTION

All forest lands of the United States lay within the temperate region, except for those in Puerto Rico, the Virgin Islands, Hawaii, Guam. American Samoa, and the former Trust Territories of the Pacific Islands. These tropical forests are but 0.25 percent of the size of U.S. forests in the temperate zone, and their contribution to the nation's economy is negligible. Thus, it is not surprising that USDA Forest Service programs have focused primarily on temperate forest management—a focus that is not likely to change.

Despite its emphasis on temperate forestry, the Forest Service is taking a growing interest in tropical forestry. In 1980, a U.S. Interagency Task Force recommended to the President a policy, strategy. and program for expanded U.S. research. technical assistance and training programs to protect and sustain tropical forest resources throughout the world (U.S. Interagency Task Force 1980). In response, the Forest Service developed an International Program for Tropical Forests whose goals are to:

- \* Mitigate the basic causes of tropical deforestation
- \* Introduce modern resource conservation technologies
- \* Improve resource management through training
- \* Strengthen knowledge and skills for tropical forest resource management
- \* Improve response technical to assistance requests.

In the Pacific Basin, implementing the program is the responsibility of two Forest Service branches: the Pacific Southwest Forest and Range Experiment Station (PSW) and the Pacific Southwest Region (R-5). The Forest Service was active in the Pacific Basin, however, long before 1980.

The Forest Service's involvement dates from the early 1900's (Nelson, [in press]). At first its role was limited to intermittent formulation of forestry policy and implementation of cooperative programs--mainly in Hawaii. That role expanded in 1957 when, at the invitation of the Territorial government. the Station established a permanent research office in Honolulu. That one-person office in time expanded to the present Institute of Pacific Islands Forestry.

By 1969, technical assistance extended beyond the shores of Hawaii to American Samoa. Guam. and the Trust Territories of the Pacific Islands. Forest Service commitments in the Pacific Basin have continued to grow since then. To handle the increased demand for cooperative state and private forestry programs. the Region established its first full-time Pacific Island Forester position in 1978. That position is headquartered at the Institute, in Honolulu.

FOREST HESOURCES OF AMERICAN PACIFIC ISLANDS

#### State of Hawaii

Hawaii accounts for about 4.1 million of the nearly 4.8 million acres of land that comprise the American Pacific Islands (Fig. 1). Forests cover 1,986,000 acres—almost one-half of the State's land area (Metcalf. et al. 1978). Each of the eight major islands support forests of one type or another. The forests represent a wide diversity of types—from low elevation tropical rain forests to arid scrub forests to temperate subalpine woodlands.

The acreage of forests in Hawaii and their general condition have declined since Polynesians first colonized the islands. That decline accelerated after 1800 because land was rapidly converted to other uses. The conversion was done to meet essential needs of a growing populace--production of food and fiber and creation of living space. The deliberate and accidental introduction of plant, insect, and disease pests to Hawaii's forests contributed to further degradation. Today, demands on the State's forest resources continue to increase as the human population grows. As of 1980, Hawaii had but 4.3 acres of land per resident (Fig. 2). only 2.1 acres of forest land per person.

#### Other American Pacific Islands

American Samoa and Micronesia. formerly the Trust Territories. which includes the Marshall. Caroline, and Mariana Islands, are spread over 3 million square miles of the Pacific Ocean (Fig. 3). More than 2,000 islands, ranging from small unoccupied atolls and rock islands to large populated volcanic islands, are found in this area. The total land area is about 650,000 acres; over 80 percent is classed as forest land.

The forests of Pohnpei and Kosrae in the Eastern Carolines, Palau in the Western Carolines, and Rota in the Northern Marianas are relatively intact, having survived war and colonial activity over the last century. Extensive mangrove forests fringe Pohnpei, Kosrae, and Palau. On most other islands, however, little remains of the original forest vegetation. Wars, repeated fires. housing development, and agriculture have reduced the forest land--some of it to unproductive savannahs and badly eroded barrens. Poor land management practices have resulted in sedimentation of the coral reefs and estuaries that fringe many of the Pacific islands (Falanruw 1980).

The population on the American Pacific islands has expanded rapidly. In 1980, Guam. the Republic of the Marshall Islands, and American Samoa had less than 2.5 acres of land per resident (Fig. 2)—even less forest land per resident. Degradation of island forest resources has accompanied the population increase. The need to produce food, fiber. and living area will not decrease in the future. Thus, we can expect increased pressure to convert island forest to uses that satisfies one or more of these essential needs.

#### CONSTRAINTS ON EFFECTIVE FOREST MANAGEMENT

The greatest need now is to provide management guidance. cultural and economic incentives, and research results to improve, restore, and enlarge island forest and agroforest ecosystems. But professional knowledge about the forest resource base and about the limitations on ecosystem productivity is inadequate to meet these needs. Furthermore, we have little experience applying our forestry knowledge to site-specific management problems in island forests. Additional applied and basic research is needed in the following areas:

- \* Ecology of different island forest types
- \* Silvicultural practices suitable for reforestation and agroforestry and the regeneration of native mixed-species forests
- \* Watershed management practices to control erosion, maintain slope stability, and insure adequate water yield and quality
- \* Fire management practices
- \* Forest weed effects and control methods
- \* Wildlife habitat requirements

Developing knowledge about these critical areas is only one step toward effective forest management. Equally important, an appropriate social structure must be in place to translate forest resource information into management plans and to implement those plans. While most islands have a natural resource agency, few have trained foresters and biologists to staff them adequately. Forestry oriented legislation and planning are under way, but additional Forest Service assistance is needed. On the negative side, exploitation by outside interests is often encouraged and local customs. such as burning, are detrimental to forest resources. Public education is needed to combat these destructive influences. The Forest Service's State and Private Forestry Branch (S&PF) is specifically charged with helping to solve these social aspects of tropical island forestry.

#### CURRENT FOREST SERVICE ACTIVITIES

The Forest Service, therefore, has a leadership role to fill-both in forestry research and in technology transfer and assistance. But we can not and do not work in a vacuum. Forest Service involvement in the Pacific is exclusively at the request of the respective governments. All of our current activities are done in cooperation with State and local governments, other Federal agencies, universities—especially the University of Hawaii, and private groups, such as C. Brewer and Company, Ltd. and Weyerhauser Company.

The Institute of Pacific Islands Forestry consists of two research units and support staff. One research unit--titled "Forest Management Research in Hawaii"--has the mission of developing knowledge needed to manage koa (Acacia koa) and koa-ohia (Metrosideros polymorpha) ecosystems so as to ensure forest maintenance and establishment, watershed stability, and weed control. The other unit--titled "American/Pacific Island Forestry Research" has activities that extend beyond Hawaii. Its mission is to assess the existing forest resources and provide research for island foresters and land managers to solve forestry problems in the American Pacific islands. These missions are in effect for five years, after which time they may be continued for an additional five years, either with or without modification, or terminated. Three years remain of our current 5-year program.

#### Vegetation Survey and Inventory

Becoming familiar with the forest resource base has been and continues to be a high priority task. Vegetation surveys have been completed for most of the major American Pacific islands, except Guam and the Marshall Islands. These surveys were the first comprehensive attempts to describe the different vegetation types, their extent, ecological function, and uses. Maps and summaries of the surveys are available through Forest Service offices in Honolulu and Berkeley, California (Cole, et al. 1987: Cole, et al. [in press]; Falanruw, et al. 1987a, 1987b; MacLean, et al. 1986; Whitesell. et al. 1986). Reports of the vegetation survey for Saipan, Rots. and Tinian in the Northern Mariana Islands are being prepared for publication.

Inventories of timber resources have been completed for American Samoa; Babel thaup, the Republic of Palau; and for Kosrae, Pohnpei. Yap, and four Truk islands (Dublon, Moon. Fefan, and Eten), Federated States of Micronesia. The results describe areas of forest land, by forest type and land class, and timber volumes, by tree component and forest type (Cole, et al. [in press]; MacLean, et al. 1988a, 1988b; Petteys, et al. 1986).

The Forest Service pioneered forest survey and timber inventory work in the State of Hawaii (Buck and Paysen 1984: Metcalf, et al. 1978; Nelson 1967). The newest approach to assessing forest resources is known as multiresource inventory. Field data are collected to encompass the needs of as many disciplines as possible, including information on wildlife, watershed, endangered plants, and timber. This approach optimizes field work, standardizes data collection, and facilitates transfer and use of information between disciplines. The Pacific Northwest Forest and Range Experiment Station (PNW), Portland, Oregon, and the Hawaii Division of Forestry and Wildlife have completed multiresource forest inventories for the islands of Molokai (Buck, et al. 1986), Oahu, and Kauai. Work is now under way on the Island of Maui.

#### Forest Management Research

Relatively little is known about management of native Hawaiian forests because of past emphasis on establishment and development of plantation species. Part of the Forest Service's current work in native koa-ohia forests deals with basic ecosystem questions, such as how is the forest organized and how do the various components function as an integrated whole. Three studies are under way to determine if nutrient availability of degraded and virgin forest soil limits productivity of young koa and ohie trees. Another study is examining decomposition dynamics of native and alien forest litter (Scowcroft 1986).

Another aspect of Forest Service research in Hawaii involves discovering how to regenerate and manage mixed-species forests on degraded forest lands. Thousands of acres of mid-elevation pasture on the islands of Hawaii and Maui could be returned to native forest over the next decade if effective reforestation techniques could be developed. The incentives for reforestation are not purely economic. The ultimate restoration of several endangered forest birds may depend on reestablishing suitable forest habitat. To that end. the U.S. Fish and Wildlife Service has about 5,000 acres of pasture in its Hakalau Forest National Wildlife Refuge that it wants returned to mixed native forest. Natural and artificial regeneration studies are under way in the Refuge (Conrad. et al. [in review]). Another study is looking at the interactions of

seed source and site on performance of young koa on Maui (Conrad and Ikawa. in these proceedings).

Additional silvicultural research in Hawaii is examining the effect of fertilization (Whitesell, et al. 1987), spacing, thinning, and other cultural practices on performance of introduced as well as native trees. On Saipan, in the Commonwealth of the Northern Mariana Islands, and on Guam, we have established species and provenance trials in cooperation with local and Federal agencies. Early findings have been used by the Government of Guam to implement tree planting projects for watershed reclamation (Newell and Noquez [in review]).

#### Research on Bioenergy Production

Scientists from several Forest Service Experiment Stations, in cooperation with the U.S. Department of Energy and the BioEnergy Development Corporation, a Hawaii subsidiary of C. Brewer and Company, Ltd., have been growing Eucalyptus trees as an alternative fuel for the generation of electricity in Hawaii (DeBell, et al. 1985; Schubert and Whitesell 1985). Research is under way to study the effects of fertilizer. spacing (DeBell and Whitesell 1988), and species on maximizing biomass production. Species and fertilizer trials for fuelwood production are also being conducted in American Samoa.

#### Agroforestry Research

Subsistence agriculture and agroforestry have been practiced successfully in the Pacific islands for centuries. However, rapidly increasing populations are straining production capacity. The Forest Service is conducting two agroforestry studies in the Pacific--one in the Marshall Islands and the other in the Yap Islands. The Marshall Islands study seeks to determine the effects of various low-cost, inorganic fertilizers on growth and yields of coconut, breadfruit. and other food- and timber-producing trees. The Yap study seeks to describe the different agroforestry systems in use there and to measure and compare their productivity.

#### Biological Control of Noxious Forest Weeds

The program of biological control of noxious forest weeds is a multi-agency effort that was started in 1983 to investigate control of forest weeds threatening native island ecosystems (Markin [in press]). The Hawaii Division of Forestry and Wildlife is the lead agency for program coordination, and it provides financial support for overseas exploration for candidate control agents. The National Park Service provides both the quarantine facilities at Hawaii Volcanoes National Park and the services of a research plant pathologist. The Hawaii Department of Agriculture reviews plans for the quarantine facility, requests for permits for the importation of potential control agents, and requests for release of control agents into the field. University of Hawaii, College of Tropical Agriculture and Human Resources encourages, supports, and conducts research in biological control of forest The Forest Service provides an entomologist and support personnel and equipment to conduct research on insects as biological control agents. A steering committee made up of representative of these agencies guides the biocontrol program.

The worst problem weed is banana poka (Passiflora mollissima), an aggressive introduced vine that changes the structural and functional characteristics of Hawaii's montane rain forests. The research under way is designed to find an insect-disease complex that only attacks and controls banana poka. It is an expensive undertaking that requires exploration in South America, poka's native land. to search for candidate control agents. Once a candidate agent is identified, collected in sufficient numbers. and successfully shipped to Hawaii, years of painstaking rearing and host testing ensue to make sure the agent is host specific. The first agent—the moth Cyanotricha necyria—has been host tested (Markin and Nagata [in press]). and the Hawaii Division of Forestry and h'ildlife has been releasing the insect into the wild since February 1988. Similar cooperative work is under way for gorse (Ulex europaeus) (Markin and Yoshioka [in review]), a thorny shrub that can dominate upland pastures; and blackberry (Rubus argutus), a forest weed (Nagata and Markin

Forestry Assistance Programs

- Complete forest resource inventories including the first cycle of the Hawaii multiresource inventory and resource inventories of Guam and other western Pacific islands
- Strengthen and accelerate mixed-species silviculture and native forest ecosystem research, including koa, ohia, mangroves. and other tropical tree species
- \* Expand the program for biological control of noxious forest weeds, including--detailed studies of the ecology and biology of potential biocontrol agents in their native habitat and detailed post-release studies of all new biocontrol agents.
- \* Develop research for the protection of damaged watersheds. including identification of methods and species for revegetation.
- Design effective forms of fire prevention and control for the tropics, based on sound sociological understanding of why people set wildland fires.
- Begin studies to identify the habitat requirements of endangered terrestrial species in Hawaii forests.
- Develop the technology for maintaining a gene bank for selected native trees of Hawaii and other Pacific islands.

The Station's first permanent research unit in Hawaii was established in 1957--just over 30 years ago. Much has been accomplished in that time in enlarging our knowledge of tropical forestry in Hawaii and the other American Pacific Islands. Much more remains to be done. The Forest Service. in partnership with other agencies and cooperators, stand ready to continue its leadership role.

Table 1--Area of forest land 1 for American Pacific islands.

by government unit.

Government unit	Area	
	Acres	Percent
State of Hawaii'	1,986,400	48.3
Territory of American Samoa <sup>3</sup>	44,804	93.3
Territory of Guam 4	105,430	77.7
Commonwealth of the Northern Mariana Islands <sup>5</sup> Saipan Rota Tinian Subtotal CNMI	21,958 16.806 19,955 58.719	75.5 80.0 79.4 78.1
Federated States of Micronesia <sup>6</sup> Kosrae Pohnpei Truk (Moen, Dublon, Fefan, and Eten only) Yap Subtotal FSM	26,991 82,509 8.937 17,231 135,668	97.6 94.1 86.7 71.8 90.7
Republic of Palau <sup>7</sup>	81,777	79.5
Republic of the Marshall ${\tt Islands}^8$	42,000	95.0

<sup>&</sup>lt;sup>1</sup>Forest land is defined as land at least 10 percent stocked by live trees and not currently developed for nonforest use. Forest land includes land currently supporting mangroves, agroforests, and secondary vegetation.

<sup>&</sup>lt;sup>2</sup>Metcalf, et al. (1978).

<sup>&</sup>lt;sup>3</sup>Cole, et al. (in press).

<sup>&</sup>quot;Government of Guam (1983).

 $<sup>^5</sup>$ Unpublished data, Thomas Cole. Institute of Pacific Islands Forestry, Honolulu. Hawaii.

<sup>&</sup>lt;sup>6</sup>Falanruw, et al. (1987a.b); MacLean, et al. (1986); Whitesell, et al. (1986).

 $<sup>^{7}</sup>$ Cole. et al. (1987). Only about one-fifth of the rock islands included.

<sup>&</sup>lt;sup>8</sup>Pers. comm., Thomas Cole. May 1988.

#### REFERENCES

- Bell, Enoch F. 1988. Tropical forestry program for the Pacific. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. 11 p.
- Buck, Michael G.. and Timothy E. E'aysen. 1984. A system of vegetation classification applied to Hawaii. Gen. Tech. Rep. PSW-76. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. 11 p.
- Buck, Michael G.. Patrick G. Costales, and Katharine McDuffie. 1986.
  Multiresource forest statistics for Molokai, Hawaii. Resource Bull.
  PNW-136. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR. 18 p.
- Cole. Thomas G., Marjorie C. Falanruw, Colin D. MacLean, Craig D. Whitesell. and Alan H. Ambacher. 1987. Vegetation survey of the Republic of Palau. Resource Bull. PSW-22. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. 13 p.
- Cole, Thomas G.. Craig D. Whitesell. W. Arthur Whistler, Neil McKay, and Alan H. Ambacher. Vegetation survey and forest inventory of American Samoa. Resource Bull. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. (in press).
- Conrad, C. Eugene, and Haruyoshi Ikawa. Species-site relationships along a rainfall isohyet on Maui. (These proceedings).
- Conrad. C. Eugene, Paul G. Scowcroft. Richard C. Wass, and Donovan S. Goo. Reforestation research in Hakalau Forest National Wildlife Refuge. Transactions of the Western Section of the Wildlife Society. (in review).
- DeBell, Dean S.. and Craig D. Whitesell. 198%. Diameter-density relationships provide tentative spacing guidelines for <u>Eucalyptus saligna</u> in Hawaii. Res. Note PSW-397. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. 3 p.
- DeBell, Dean S., Craig D. Whitesell. Thomas H. Schubert. 1985. Mixed plantations of <u>Eucalyptus</u> and leguminous trees enhance biomass production. Res. Paper PSW-175. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 6 p.
- Falanruw, Marjorie V. C. 1980. Marine environment impact of land-based activities in the Trust Territory of the Pacific Islands. p. 23-47. <a href="In:">In:</a>
  Marine and coastal processes in the Pacific: ecological aspects of coastal zone management. <a href="14-17">14-17</a> July 1980. Motupore Island Research Center, University of Papua New Guinea. UNESCO.

- Falanruw. Marjorie C., Thomas G. Cole. and Craig D. whitesell. The vegetation of acid soils of Micronesia. In: Proc. III international soil management workshop, management and utilization of acid soils in oceania (J. Demeteria, ed.). 2-6 Feb. 1987, Republic of Belau. University of Guam, Agana, Guam. (in review).
- Falanruw, Marjorie C.. Thomas G. Cole, Alan H. Ambacher. Katherine E. McDuffie. and Jean E. Maka. 1987a. Vegetation survey of Moen, Dublon, Fefan, and Eten, State of Truk, Federated States of Micronesia. Resource Bull. PSW-20. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 6 p.
- Falanruw. Marjorie C.. Craig D. Whitesell, Thomas G. Cole. Colin D. MacLean, and Alan H. Ambacher. 1987b. Vegetation survey of Yap, Federated States of Micronesia. Resource Bull. PSW-21. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 9 p.
- Government of Guam. 1983. Forestry resources program plan. vol. 1. Department of Agriculture, Forestry and Soil Resources Division, Agana, Guam. 61 p.
- MacLean, Colin D.. Thomas G. Cole. Craig D. whitesell. and Katherine E. McDuffie. 1988a. Timber resources of Babelthuap, Republic of Palau. Resource Bull. PSW-23. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.
- MacLean, Colin D., Craig. D. Whitesell. Thomas G. Cole, and Katherine E. McDuffie. 1988b. Timber resources of Kosrae, Pohnpei. Truk, and Yap, Federated States of Micronesia. Resource Bull. PSW-24. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

MacLean,

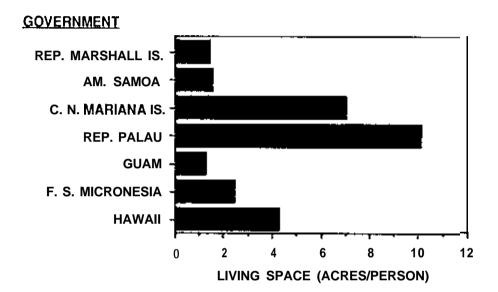
- Metcalf, Melvin E., Robert E. Nelson, Edwin Q. P. Petteys, and John M. Berger. 1978. Hawaii's timber resources. 1970. Resource Bull. PSW-15. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 20 p.
- Nagata, Roddy F., and George P. Markin. 1986. Status of insects introduced into Hawai'i for the biological control of the wild blackberry Rubus argutus Link. p. 53-64. <u>In: Proc.</u> sixth conference in natural sciences (C. W. Smith and C. P. Stone, eds.). 13 June 1986, Hawaii Volcanoes National Park. Hawaii. Cooperative National Park Resources Studies Unit, Dept. of Botany, University of Hawaii, Honolulu.
- Nelson, Robert E. 1967. Records and maps of the forest types in Hawaii. Resource Bull. PSW-8. USDA Forest Service. Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. 22 p.
- Nelson, Robert E. The USDA Forest Service in Hawaii: the first 20 years (1957-1977). Gen. Tech. Rep. USDA Forest Service, Pacific southwest Forest and Range experiment Station, Berkeley, CA. (in press).
- Newell, Leonard A., and Carlos L. T. Noquez. Afforestation of eroded acidic soils in southern Guam. In: Proc. III international soil management workshop, management and utilization of acid soils in oceania (J. Demeteria, ed.). 2-6 Feb. 1987. Republic of Belau. University of Guam, Agana, Guam. (in review).
- Petteys. Edwin Q. P., Salis Peter. Raymond Rugg. and Thomas G. Cole. 1986. Timber volumes in the mangrove forests of Pohnpei. Federated States of Micronesia. Resource Bull. PSW-19. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley. CA. 2 p.
- Schubert. Thomas H.. and Craig D. Whitesell. 1985. Species trials for biomass: a first appraisal. Res. Paper PSW-176. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 13 p.
- Scowcroft. Paul G. 1986. Fine litterfell and leaf decomposition in a montane koa-ohia rain forest. p. 66-82. <a href="In: Proc.">In: Proc.</a> sixth conference in natural sciences (C. W. Smith and C. P. Stone, eds.). 13 June 1986, Hawaii Volcanoes National Park, Hawaii. Cooperative National Park Resources Studies Unit. Dept. of Botany, University of Hawaii, Honolulu.
- U.S. Interagency Task Force. 1980. The world's tropical forests: a policy, strategy and program for the United States. Department of State Publication 9117. United States Department of State, Washington, DC.
- Whitesell. Craig D., Dean S. DeBell, and Thomas H. Schubert. 1987. Six-year growth of <a href="Eucalyptus saligna">Eucalyptus saligna</a> plantings as affected by nitrogen and phosphorus fertilizer. Res. Paper PSW-188.

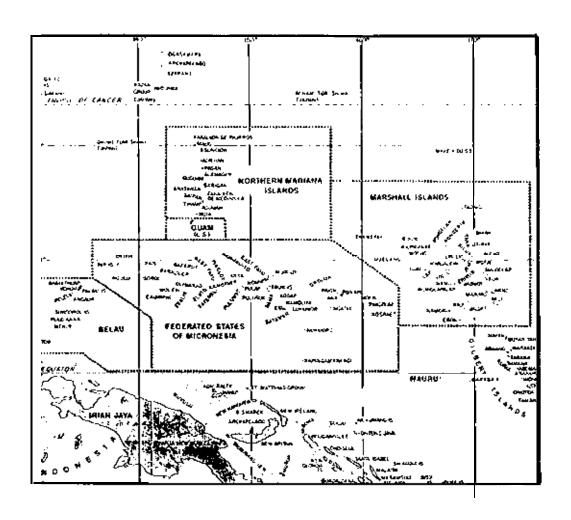
#### FIGURE: CAPTIONS

- Figure I. Land area (acres) and populations (1980 census) for Pacific islands under United States influence. (Adapted from Bell 1988, Table 1)
- Figure 2. Living space for American Pacific island populations. (Adapted from Bell 1988, Table 1)

Figure 🐉







# WESTERN REGIONAL WORK PLANNING CONFERENCE June,, 13-17, 1988

### Committee I Soil Technology Transfer

#### COMMITTEE I MEMBERS

Gary Muckel Alan Amen Tom Collins Richard Dierking Charles Goudey Gerald Nielson Steve Borchard Maurice Mausbach Russel Yost Harry Sato H lkawa R.T. Meurisse Gordon Decker Bob Kukachka Joe Moore Jim Collins **Daniel Ernstrom** 

Within the soil survey program there is a constant need for various kinds of information or data. Information is needed to make soil surveys and information is also needed once the soil surveys are complete.

#### **COMMITTEE CHARGES:**

- \* Identify needs in the transfer of soil technology within NCSS and to others.
- \* Propose methods to meet the needs identified by the committee.

#### **RECOMMENDATIONS:**

As a result of the committees work we have identified several apparent needs and proposed three separate task forces to help meet those needs.

The first need we have identified is to have access to each others data. This includes data being made available to all cooperators within NCSS and to others who have use for soils information we may have.

There is a lot of soils information that has been collected by the various cooperators within the NCSS program. Some of us know where some of it resides and some of us have access to some of the data. At the same time there is probably a lot of data that would be useful to each of us in our projects that we are not aware of or that we do not have ready access to.

There are several possible reasons for a lack of access to the data generated by the various cooperators. Those we identified are:

- 1. Security of computer systems.
- 2. Format of information and incompatibility of systems
- 3. Lack of knowledge of the availability of the information.
- 4. Unwillingness to make information available to others.
- 5. Status of information (uncorrelated vs correlated etc.)
- 6. There may be more...

To meet this need we have proposed the use of two task forces.

#### Tusk force I

Review and amend as needed any Memoranda of Understanding between the agencies involved in the NCSS with the purpose of making each others *automated* soil related data available in a format useful to each other.

This Task force should address things such as:

- I. What kind of information should be made available?
- 2. Who should be the responsible party within each agency for making the information available?
- 3. In what format should the information be made available?
- 4. What information should most appropriately come from each agency?
- 5. What is the most appropriate access fc the. various data?
- 6. What should the status of information be that is being made available?

  A. Correlated? To everyone?
  - B. Uncorrelated? To selected users?
- 7, How can we insure that everyone is aware it is ok to share?

#### Task Force 2

Determine the feasibility for an NCSS "bulletin board" (or database) which has information about what is available within NCSS, where it is stored and how to access it. Items to address are:

- I. Who should maintain the bulletin board? (WNTC? Database staff at Lincoln?)
- 2. How it should be funded?
- 3. How to access the bulletin board
- 4. Structure of the bulletin board
  - A. Menu Driven?
  - B. System?
- 5. How to obtain information to store in the bulletin board. (solicitation within agencies, or in professional journals) etc.
- 6. How to publicize the bulletin board?
- 7. What information is available now for the bulletin board?
- 8. What are some future needs that can be met by use of a bulletin board
- 9. How can all cooperators access the bulletin board?
  - A. Telenet?
  - B. Appropriate communication software?
  - c. Etc.

The <u>second need</u> we have identified is to obtain the needs for soils information by the various users of that information and to provide that information to the appropriate <u>database</u> designers and policy makers.

In order to make information useful and obtainable it is helpful for the developers and designers of soil datahases to have an idea of the types of information needed by users, the format most appropriate for that information and how the information might be used. An NCSS bulletin hoard would be a good place to make the needs for information and format for the information known.

It may very well he that some of the things mentioned are already being researched or implemented however we would benefit by communication about what the various people are working on within the NCSS. The NCSS bulletin board would be a good place to communicate this information.

The <u>third</u> and one of the most pressing needs being felt in the transfer of soil information is the lack of sufficient staff to provide the information to the users in the most useful format..

With the advent of the computer age and database management systems we have the ability to make use of more data and do more productive things with the data than ever before. To be able to properly take advantage of the new innovations available to us we need to have sufficient staff who can manage the data.

What is needed within each of the agencies or at least where the databases will reside are dataset managers with a proper background not only in database management but in the case of soil survey information, a background in soil survey.

An awareness of this need is becoming apparent however until we realize how important the need is we may not physically be able to provide each other with the data we have been talking about.

No task force was recommended by this committee but it might be good to consider one.

# COMMITTEE 2 -INFORMATION AND DISPLAY OF SOIL SURVEY PUBLICATION

#### COMMITTEE MEMBERS:

Gerald Latshaw, SCS, Portland, Oregon, Chairman Al Amen, BLM, Denver, Colorado James Carley, SCS, Spokane, Washington Gordon Decker, SCS, Bozeman, Montana Herh Holdorf, USFS, Missoula, Montana Herb Huddleston, OSU, Corvall is, Oregon Don Jones, BIA, Portland, Oregon Harold Maxwell, SCS, Boise, Idaho Ray Miles, SCS, Portland, Oregon Joe Moore, SCS, Anchorage. Alaska Jack Rogers, SCS, Reno, Nevada

#### COMMITTEE CHARGE:

To evaluate alternative methods of presenting soil survey information to users including determining how best to fully utilize computer technology in publication of soil survey reports.

The committee charge was organized into specific issues so the ideas and thoughts of the members could he organized prior to the conference. The following issues were considered and recommendat i ons made by the committee.

#### Issues and Recommendat i ons:

- 1. Are there some alternate publication formats that we should consider other than the present for-mat nut lined in the National Sni Is Handbook?
  - a. Semitabular format for map unit descriptions was highly recommended as an alternative. The cited advantages include ease of use to locate specific items in description, hetter adapted for storage and retrieval from database(i.e., CAMPS). The format makes it easier to compare soils for select features for a soil survey or other soil surveys.
  - b. More consideration is needed to utilize graphic displays. This could effectively assist in defining relationships of soils data, interpretations, and map unit characteristics. The graphic software packages can offer many possibilities including graphics to assist in the nontechnical soil description.
  - c. The availahi I ity and use of computers in the soil survey is changing our needs and capabi I it ies for

providing the soil survey to the users. The number of publishedsoilsurveys needed for distribution will be reduced as more users utilizeGIS and databases. We foresee the continuing need for the published report for many soil surveys. Some users need a complete package of maps, soil descriptions, and soil data, and the published report provides an excellent quality package with minimum time required from the field office. This is becoming more important as field office staffs become smaller. Format changes recommended for publication include multivolume reports such as:

- Volume I Soil descriptions; legend, soil data inc luding the portions of the present soil survey considered the mare technical (i.e., classification and formation). This would be the basic soil information that requires few changes over the useful life of the soil survey.
- Volume II Soil interpretations. These would be yield tables, forestry, range management, and other interpretations that become outdated in a few years.

Volume II could be printed periodically to update the soil survey and/or the users could be provided tai lured interpretations from printouts from the databases (3SD, CAMPS, etc.). A three-volume report could be considered by including the maps in a separate volume. These changes would reduce costs of updating the soil survey.

Another option is to publish only one volume including on ly the basic so il survey information (maps, descriptions, properties, classification, etc.) and to provide the so il interpretations and management statements in a nonpublished form.

2. Are there some improved methods or ways we can utilize the computer to prepare, review, and edit the soil survey for- publication? (Many states are using computers at soil survey offices to store the manuscript so the initial keying will be maintained except for- the needed editing and updating for publication.) Do you have more ideas on expediting the procedure?

The committee members support the need to utilize the computer in the development of the soil survey manuscript. Some cited advantages include:

- a. Lack of typing assistance for soil survey party.
- b. One time keying of manuscript.
- c. Ease of updat ing.
- d. Frovides more options and stimulates innovations in manuscript development.
- e. Allows interaction of existing database (3SD) and the manuscript. Manuscript data can be added to the county soil survey database (CAMPS).

Some improved methods being used or proposed include:

- a. Use of R: base System V database functions under MS-DOS operat in 3 system (Nevada) to develop map unit descriptions. This program allows cross-checking data entered for the map unit with computer-rather than manual checks.
- b. Frogram "MUD Writer" developed using MS-WORD for writing mapping unit descriptions using a system similar to CAW (Oregon).
- c. Computer is used to store field soil descriptions (SCS-SOI-232), and a program will generate the block soil descriptions for the manuscript and official series descriptions. Transect data is entered and the data analyzed and summar ized to deter-mine map unit composition (Alaska).
- d. Desktop publication is supported. This should speed manuscript processing, allow more flexibility, and reduce costs.
- 3. Are theretetter ways to develop, display and/or present map unit descriptions to increase usability? Whether fact or fiction, the assertion is that the present map unit descriptions are difficult to use. What can we do to improve the descriptions and the usability?

It is generally agreed there is no way to satisfy the needs of all users in the format content and detail of map unit descriptions. Fersonal bias and prejudice can adversely affect reaching agreements on best methods to present map unit descriptions. The following guides are recommended in considerin 3 the format and content.

 a. Present 'so ils information in a simplistic and abbreviated format. (The tabular format should work well for this.)

- b. Organize the material in a logical arrangement that will maximize the efficient location and extraction of information.
- c. Assuming reasonable success in achieving the above, users who are compelled to reformat and reorganize the data to suit their personal desires should be able to easily accomplish this.

The point was made that more effort is needed to train users on how to use the survey and particularly in the concepts of map units including design, mapping procedure and mapping intensity.

4. Are there better ways to present soil interpretat ions and soil properties in the soil survey than the present methods? Present methods include the presentation in standard tables and statements in map unit descriptions.

Graphics could be better- utilized to display some interpretations and properties. Computers will encourage some innovations in this direct ion. Sever-all comments indicated there is more need to review and improve the kinds of interpretations provided rather than change the method of presenting. For example, do the limitation ratings provide useful information to the user groups? Are we providing interpretations that are not appropriate (i.e., golf fair-ways in order 3 soil survey). These questions may be especially applicable for public lands. The development and use of the soil survey database will provide the opportunity for more flexibility in presenting more applicable interpretations for the survey area.

5. Are there better ways or procedures for preparing soil maps' for publication and use? Center most of your comments towards digitizing soil maps in regard to map measurement, map finishing, publication and utlization by the map User-s.

The committee members agreed digitizing the soil survey is the direction we should be going to assist in publication and use. Digitizing the soil survey concurrently With mapping will be the best procedure as we gain the capability. The early digitizing will allow early use of the soil survey and provide a means for-map measurement and map finishing needed for publication. All though GIS systems are beingused, it is apparent we have only scratched the surface on the potentialuse of digitized soil maps and databases.

The preceding comments and recommendat ions are reflect i ons from the individual

#### COMMITTEE 3 - ALTERNATIVE FORMATS

#### COMMUNICIPE MEMBERS:

\*Goe Downs, SCE, Sait Lake City, Utali, Coairperson
\*Car! Alexander, USDA: Forest Service, Region 10, Alaska
\*Dave Nichmond, SCS, Phoenis, Arizona
\*Jerry Simonson, Oregon State University, Corvalius, Oregon
\*George Staidl, SCS, National Soil Range Team, Keno, Nevaoa
\*Steve Leonard, PLM, National Soil Range Team, Reno, Nevaoa
-Richard Dierking, SCS, Portland, Oregon
- Will Morr, USPS, Arbuquerque, New Mexico
- Richard Fiper, USDI-FOR, Denver, Colorado

\* In attendance

#### COMMITTEE CHARGE:

Determine how best to fully attitize computer technology in patrication of soil survey reports. These include alternative formats, display and presenting soil descriptions, properties and interpretations and soil maps on hard copy, GIS systems and/or digitized maps.

ASSUM 1: Present publication formative, new direction

RECOMMENDATION: Nost of our users prefer the semi-tabular manuscript format. A recommedation is that the manuscript be put on computer only and stored at the state office, field office and a central state repository that can be accessed by the general public. This will allow a user to obtain only those portions of a publication needed without having to obtain the entire publication. Since many public users lack computer capability to access the information hard copies of soil surveys are still needed for the forseeable future.

Software programs as they apply to Soil Survey manuscripts are gaining in importance. Modification of the prewritten material to fit the needs of the state and downloading it to word processors and computers compatible with the MIC editors is an example. With the proper links between computer systems air or parts of the manuscript can be downloaded to office systems depending on the need of the user.

Reports for entire soil survey areas may not be necessary. We still need reports for the entire soil survey area, but for a specific user we may need to print only those map unit description, pertinent taxonomic unit description and needed interpretation for the area of interest.

1880E A: Present table formats as represented in soil survey publications vs. what can be pushed from computers.

RECOMMENDATION: We suggest tables that are generated from the state SSSD be used in place of the formats currently used. This will allow for more localizing of data for interpretive uses.

liems that can be accompirated by a task force in the next two years.

 Look at ways to modify present hand copy sort surveys so that they are more compact and user friendly.



capability that will limit with other data systems and programs allowing  $f_{\rm eff}$  output to accommodate various reports and soil survey manuscripts.

Report from the Committee on Remote Sensing and GIS.

The charges presented to the committee were to:

- 1) Define GIS
- 2) Identify use of BIS for making soil surveys and using correct soil surveys.
- 3) Provide initial recommendation for implementing 61S in NGSS.
- 4) Display examples of 613 applications.
- 5) Provide an appendix of various GIS systems, costs, and advantages and disadvantages of each.

The committee decided that since remote sensing technology was well documented in our last conference, it would be redundant to address this topic again. However, we do emphasize that remote sensing is a data collection tool that can supply information into a bis.

GTS is defined as a spatial information system that includes a cata encoding, data analysis, relational database and cantographic cutput subsystems.

In our last conference report, this committee has identified a major note for remote sensing in making sold surveys. We believe that there are several ways in which a GIS can also be used in making a soil survey. These include:

- DRegistration of pass maps into a computer.
- Diferenation of stope, aspect and elevation wass as aids in field mapping and mapping unit design.
- 6-A means for digitating field sheets as they are concleted and a way for correlating and tracking the soil survey in an actorated environment.
- AsAn efficient was to edge match, compile maps, and chiculate mad acreages.
- 5~A way to quickly generated a general soil map from the detail maps.
- 6)A means to use satallite data on imagery as an overlay to verify field mapping and determine appropriate soil sampling sites.
- 7)A means to orgate terrain (lancecape) models and profile models.
- SIA means for storing and creating a sold survey manuscript in an automated environment.

As to the role of GIS in using current soil surveys, it is essential that the current soil surveys be digitized. It is also desirable that older surveys be confiled onto a registered hase before digitizing.

Once current soil surveys have been digitized, and the tabular and attribute data have been incorporates into a

GIS, a myreac of spatial data analyses and be performed. The relational database and statistical analysis in a GIS are the capabilities that provide a powerful analytical tool for resource Managers.

For example, any map and combination of maps can be added, subtracted, or menged to produce a new map. An unlimited number of thematic overlays can be created depending on the users' needs. In addition to the treation of new maps, measurements can be easily accomplished in a GIS. For instance, areas, volumes, distances and productives can be easily chiculated.

Att of those things that a resource manager do with maps and geographic data can be performed in a 61%. Reports with appropriate graphics such as maps, graphs, charte, and tables can be easily generated.

The committee believes that it would be impractical to attempt to list all of the possible applications from a GIS; however, we explication of the user. For this reason, just a few examples are displayed as one of the charges have indicated.

As for implementing GIB in NOSS, many of the cooperators are already using this technology. Several agenties have made major core todays in terms of Equipment and staff to GIS.

Collais the GSS users polled, the major reschis series unvey such as digital former. Many of the users indicated that digitaled soils data as a primary layer were crucial to their CIS. Since soils data are the most essential layer, digitating the soils data is one requirement for a successful geographic database. Unfortunately, this is one or the costlicit part of a GIS. Digitazing soils is still a technician could digitate a T.S menute orthophetoguad of soirs data in 16 hours at a cost of about 300 to 400 dollars per deat. With improved fiber optics technology, maps can be seen digitated in the very hear future. The results from current scanners do not justify the cost.

In conjunction with digitizing, the committee indicated a need to identify the various linds of GIS softwares that are availed a. Generally speaking, GIS softwares can be categorized into two categories: inpublic bowlin- those softwares that were developed by some government entity and is available without licensing cost to users.

CARCONOMICS (CONTACTOR AND ADMINISTRATION ADMINISTRATION ADMINISTRATION AND ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION ADMINISTRATION A

Currently, the more widely used public domain GIS packages are: MOSS(Map Overlay Statistical System), 6RASS(Geographic Resource Analysis Support System), and SAGIS(Systems Applications Group Information System).

There are numerous private sector 61S softwares. Some of the more common ones are: Archinfo, Aegis, Maps, Ultimap, Tydac, Intergraph, Erdas, and Synercom.

In general, the committee suggested that a proper and useful software be identified first before purchasing the hardware to support it.

In order to implement GIS in the NUSS, the committee recommends the following:
1)All current project soil surveys be digitized by adhereing to digitizing standards that have been approved by the Federal Government Erchange Format committee.

2)Att FSA farmtand mapping be digitized so that a digital database be created to maintain this data.

3)Decide on software first, then acquire the necessary harowere.

4)All new soil surveys be digitized and captured in a GIS so that magnetic tapes or disks be disseminated to users instead of the time-consuming hand copy printing routine. Hand copy reports copic still be generated from the GIS.

5 large process by needs to support project son; surveys be done in a GIS.

6) NATS63 and SIATS61 be maintained in a 618.

74Moler: for soil erosion and nutrient and pesticioe movement through soils be performed in a GIS.

Much discussions were raised about the compatibility of data between the various agencies. While this is a legitimate time on, as long as the digitizing is in some standard format and other time graphic data are in the DLGS (Digital Line Graph Option 3) format, the data can be imported into any GIS. Tabular and attribute data can be imported into a relational database.

One way to avoid compatibility problems is to set up a formal network or GIS users such as the No.IS group (Northwest Land Information System). This group was established in Portland, Oregon involving about 18 Federal and state agencies in two states. The group intends to share data and work on joint projects. Various agencies have responsibility to maintain certain data sets (layers). The group is organized into a mangement group and a

technical work group. The former provides top level support in terms of FTE, budget etc. The latter group determines projects, data exchanges and database management functions. One of the products of this effort is the creation of a database showing who has what data in what format, and the contact person. This concept is a viable approach and is long overdue.

For the final charge, the appendix illustrates the costs for various GIS systems. The committee did not list any pros and cons of the systems at this time because of inadequate documentains by the various users. The committee believes that a future report could include this information.

Committee Numbers:
Mon S. Yee , chair
Archard Herriman, SCS, Calif.
Ferris Aligood, SCS, Utar
Dick Fage, BLM, Utah
Eyron Thomas, BLM, Ore.
Bob Megrisse, FS, Ore.
Don Jones, BIK, Ore.
Mike Aniting, SCS, Calif.

# $\begin{array}{c} \text{GRASS} \\ \text{Detailed Hardware Configuration} \end{array}$

1003D 3B2/400 Bt, 2MB RAM, One I/O Board, and 54MB Hard Disk	
1003F I/O Board 73202 (3B2)	
10035 PC-6300 with one Floppy 3703.010  10031 Mother Board (512 KB)  2015 RAM Upgrade to 640 KB  1003E 10MB Hard Disk (PC-63001  1003G Keyboard 37301  PC-6300 Connector 2750-C12  Power Conditioner IBAR 8-15	
2016A RGB Color Monitor 37318 2016B Display Enhancement Board	
Kurta Digitizer with 16 Button Cursor, 24" x 24" Tablet PC-6300 Connector  2011A 2011B	

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2006

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## USDA'SCS COST PROPOSAL FOR GIS & HARDWARE PERIPERALS **ESRI-** NORTHWEST June 8, 1988

#### **PLOTTER**

CalComp 1044GT Dual Mode (cut sheet & continuous paper feeder):

- eight pens (up to eight colors at a time)
- A through E size (34 inch width X 100 feet length maximum of actual plotting area)
- Vacuum column paper feed
- RS232 serial communication
- cables, paper, & pens Included
- -installation & 90 day On-site Warrenty included
- interfaces to ESRI's PCI plot and VDI device drivers supplied with ARC/INFO and pcARC/INFO without additional software
- estimated monthly maintenance \$ 35.00

Price': \$13,900.00

'Price Includes shipping charges

## CalComp 1043GT Cut Sheet:

- eight pens (up to eight colors at a time)
- A through E size (34 inch width X 47.4 Inch length maximum of actual plotting area)
- RS232 serial communication
- cables, paper, & pens Included
- -Installation & 90 day On-Site Warrenty included
- interfaces to ESRi's PCI plot and VDI device drivers supplied with ARC/INFO and pcARC/INFO without additional software
- estimated monthly maintenance \$ 25.00

Price\*: \$8.905.00

\*Price includes shipping charges

CalComp 1042GT Dual Mode (out sheet & continuous paper feeder):

- eight pens (up to eight colors at a time)
- A through E size (34 Inch width X 50 Inch length maximum of actual plotting area at a time)
- Pinch driven paper feed
- -R3232 serial communication
- cables, paper, & pens Included
- installation & 90 day On-site Warrenty Included
- Interfaces to ESRI's PCI plot and VDI device drivers supplied with ARC/INFO and pcARC/INFO without additional software

ERSI

- estimated monthly maintenance - \$ 25.00

Price\*: \$9.900.00

#### **DIGITIZER**

CalComp 91480 Non-Backlit 36 inch X 48 Inch:

- 36 Inch X 48 Inch surface size
- 16 button cursor
- 2 amp power supply
- Dual R\$232 ports with cables
- High accuracy (0.005 accuracy)
- Power base
- 90 day On-site Warrenty included
- estimated monthly maintenance \$ 98.00

Price\*: \$7,235.00

'Price Includes shipping and install charges

<sup>\*</sup>Price includes shipping charges

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A. USDA/SCS Cost Proposal for IBM Compatible Microcomputer pcARC/INFO GIS Software

pcARC/INFO

Starter Kit pcOverlay **pcARCEDIT pcARCPLOT** pcGrid Conversion **PCNETWORK** 

PC INFO Software Total \$ 2,000.00

\$ 1,600.00 \$ 800.00

\$ 800.00

\$ 850.00

# Hardware:

Sun 3/80FC-8-P14 8 MB Memory 327 MB Hard Disk 16' Color **Monitor** (1152x900) 60 MB 1/4" Tape Cartridge SunOS/SY\$L2 Keyboard, Mouse, Installation

**2**2067544727

& Shipping

Cost: \$ 23400.00: Estimated Monthly Maintenance - \$260.00

#### C. USDA/SCS Cost Proposal for Data General MV8000 - ARC/INFO GIS Software

# ARC/INFO:

\$ 49,500.00

Network/TIN:

\$ 15,000.00 each

Current Annual Software Maintenance (after 1st year) - Primary Site ARC/INFO:

\$ 8,500.00

Network/TIN:

\$ 1,100.00 each

Training:

\$2,500.00/seat at Redlands, CA (ARC/INFO & Network)

\$15,000.00 on-site (up to 10 people - ARC/INFO & Network)

\$ 500.00/seat at Redlands, CA (TIN)

\$ 3,000.00 on-site (up to 10 people - TIN)

Installation:

\$ 6,000.00 on-site Installation

1988 Western Regional Technical Work-Planning Conference of the National Cooperative Soil Survey, Kahului, Maui, Hawaii, June 13-17, 1988

REPORT OF COMMITTEE No. 5: CHARACTERIZATION OF NSSL PEDON-SAMPLING SITES

# Committee Members:

\*Fred Peterson, UNR, Reno, NV, Chm.
Gene Begg, UCD, Davis CA
\*Alan Busacca, WSU, Pullman WA
\*Tom Collins, USFS, Ogden UT
\*Maynard Fosberq, UI, Moscow ID
Jerry Harman, BLM, Denver CO
\*George Hartman, SCS, Casper WY
Richard Herriman, SCS, Davis CA
\*Cliff Montagne, MSU, Rasaman



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#### Discussion of Recommendations

The subject of this committee report is the adequacy for sampling-site description of the selection of site characteristics used, and the terminology provided in the 1979 "PEDON Coding System for the National Cooperative Soil Survey." The site-description characteristics used are:

Major Land Resource Area
Latitude/Longitude
Slope percentage
Slope aspect
Microrelief
Soil-surface features
Parent material weathering
PM deposition/accumulation mode
Bedrock fracturing
Average soil temperatures
Water table
stoniness
Soil drainage

MLRA Subdivision
Elevation
Slope shape [up-down]
"Geomorphic component"
Position on slope
Physiography [landform]
Bedrock inclination
PM origin [lithology]
Average air temperatures
Average annual precipitation
Land use
Permeability, excl. surf.
[Vegetation not included]

The committee considers the kinds of site characterization items selected to be generally adequate, with the glaring exception of the lack of a vegetation item. This deficiency, and those in landforms and microrelief suggest the system's authors were not conversant with the needs of range and forest land soil surveys or site characterization concepts that are regularly used in them. In summary, the deficiencies are:

- (1) No vegetation description.
- (2) Inadequate concepts and terminology for physiography (landforms).
- (3) Inadequate terminology for microrelief.
- (4) The "geomorphic component" concept is inadequately presented and the "slope components" are inadequately illustrated.
- (5) Slope shape is requested only for one (which?) direction.
- (6) Stoniness should be more broadly viewed as surficial rock-fragment cover.
- (7) Soil-surface features do not adequately cover range and forest soil situations.
- (8) An inadequate presentation and explanation of the

#### Vegetation Description

For use in range and forest land **situations**, provision should be made for listing at least six plant species that are growing at the site and for naming the kind of ecological site, potential **natural** vegetation, etc., considered normal for the soil and site.

#### Landform Terminology

This partly-inadequate site-description system is the one presently used by the National Soil Survey Laboratory (NSSL), but there have been two later updates of landform and site description terminology within the SCS that must also be considered because they will figure in any final pedon sampling-site description system. The first update is the 1986 "Glossary of Landform and Geologic Terms", National Soils Handbook, Part 607 (NSH Part 607); the second update has been during development of a new, 1987, SCS "Pedon Description Program" for national storage of pedon description data.

Appendix 1 lists the landform terms for the two categorical levels of landform identifications, the so-called "major" and "local" landform categories, that are used in the latest, 1987 pedon description program. The 1987 landform names apparently were selected by editing the 1979 list and adding numerous terms from the 1986 Glossary. In Appendix 1, terms from the 1979 list still used are noted with an asterisk (\*); terms that were in the 1979 list but were dropped or revised are noted with a pound sign (#). The remaining, unmarked terms are mostly from the 1986 Glossary. The terms in the updated, 1987 list are better choices than the 1979 list, but still are inadequate. Note that NSSL pedon sampling-site descriptions are still being made from the 1979 list!

The 1986 "Glossary of Landform and Geologic Terms", National Soils Handbook, Part 607 (NSH Part 607) added numerous landform terms that were needed and gives good definitions for most. This glossary is a major improvement, but it still lacks complete landform terminology and, most seriously, it is only a listing -- it does not present its landformidentification terms as a hierarchical classification. In this list, the relative generality or specificity of any particular landform term can be only implied or briefly mentioned in its definition -- it can't be seen by the position of the term in a hierarchy. Furthermore, the number of detailed landform terms provided for different kinds of landscapes (e.g., shorelines vs. intermontane basins vs. plains vs. mountains vs. till plains vs. coastal plains, etc.) and the adequacy of the terms selected for a particular kind of landscape cannot be judged from a list within which the terms for different kinds of landscapes are mixed together and mixed with other terms for geologic material and processes. But, the list of landform terms in this "Glossary" is much better than that in the 1979 pedon coding system, so if an analysis of the "Glossary" terms shows inadequacy, there should be no question but what the 1979 list needs wholesale replacement.

In Appendix 2, for the purpose of displaying relations between different landform names, and displaying the adequacy with which sampling-site locations in different kinds of landscapes can be described by the available terms, the landform designations in the NSH 607 "Glossary" have been fitted into a semi-arbitrary, hierarchical classification that has six categorical levels and is

printed as a table. A number of synonymous terms from the glossary have not been entered in the classification. A "umber of terms not in the NSH 607 "Glossary" have been added; these are in bold print.

The two lowest-level categories, V Landform Element, and, VI Slope Component, have been used to hold the "Geomorphic Component"-type designation of the 1979 pedon coding system and the slope component designations of that system. These subclasses apply to most erosional landforms and should be listed for each of them, but in Appendix 2 they are show" only once at the beginning of the classification to save space.

The top-level category number I has not been named, i.e., it is show" as "(?)", but it should hold the names of the geographically largest, or morphologically most distinctive landforms, or "kinds of landscapes." As examples, mountains are quite different from plains (e.g., the Great Plains) and both cover large areas and include numerous smaller landforms. However, plains (sensu "Great Plains") are not too different from coastal plains (e.g., Atlantic & Gulf Coastal Plain), but the separation is made here on the suspicion there are pedologically quite distinctive landforms in the two areas. An eve" more questionable top-level class is that of shorelines, but it has so many more subsidiary-class distinctions listed in NSH 607 than do the piedmont, plateau, plain, coastal plain, karst plain classes that "shorelines" are show separately. (This might be a measure of lack of balance in the selection of landform terms in NSH 607.) The hill and mountain classes of the top category have a" embarrassing brief selection of subclasses, although the changes in soils from one landform position to another can be noteworthy.

The selection of landform terms for sampling-site description is clearly inadequate. In particular, the landform classifications of the Forest Service need to be exploited. We need to ask if there aren't some rather significant landform positions for soils on the Great Plains other than "plain" or "pediment" (the selection available in NSH 607):

Selecting and organizing landform terms will require some guiding policies; these are suggested:

- (1) Landform terminology should be developed as a hierarchical classification, using 5 or 6 categories, and the terms presented in a tabular form that emphasizes the hierarchical relations between terms.
- (2) The terms should be morphogenetic inasmuch as possible.
- (3) Terms from the geographical-geological literature should be used where possible, but coined terms should be admissible.
- (4) Terms do not have to be entered in every sub-class position (e.g., a soil can be on the summit (category VI) of a mesa (category I) without requiring class names for categories II-V). The same "umber of subclasses is not required under each class (i.e., this is a hierarchical classification, not a binary key.)

- (4) Synonyms should be prominently listed, or footnoted to preferred terms. Distinctive terms should be used for different landscapes, rather than repeating the same root-word ad infinitum, e.g., there are too many "terraces' for too widely differing morphogenetic situations, such as stream terraces, fan terraces, outwash terraces, and marine terraces, etc. The number of "terrace" terms can be reduced, and distinctive genetic relations emphasized, for example, by "fan terraces" being called "fan remnants."
- (5) The so-called "geomorphic components" and "slope components" should be among the lowest categories of the landform classification rather than separate descriptive items.
- (6) No landform classification, regardless of its length, will adequately describe all soil situations. Provision must be made for two or three lines of free-form landscape description to be used at the discretion of the field soil scientist to describe the soil's setting in the landscape where that setting determines the soil's behavior or properties.

# Microrelief and Position on Slope

Only microrelief height and patterns of mounds and depressions are provided in the 1979 system. Morphogenetic terms such as those listed in Appendix 3 need to be added by the next committee. The "pedon position on the slope" item in the 1979 system is confusing. For example: the nine classes provided allow one to locate a pedon on a crest, but not a summit. Although a polypedon could be both "on slope and depression", how could a pedon? And, is the distinction between the upper or lower third of a mile-long mountain slope or fan piedmont the same as the upper and lower thirds of a 1000 meter-long slope under a corn crop? The next committee needs to rethink this item.

# Geomorphic Component, Slope Component, and Slope Shape

The so-called "geomorphic components" (interfluve/upland ridge, headslope, sideslope, noseslope) should be listed under some other generic rubric -- "geomorphic" is overworked -- and re-thought. They may not have the completely expansible scale of application implied.

The "slope components" (crest/summit, shoulder, backslope, footslope, toeslope) need to be better defined and illustrated. They also may not have the completely expansible scale of application implied.

Slope shape apparently is considered only in one direction, presumably perpendicular to the contour. In the 1987 pedon description program slope shape both parallel and perpendicular to the contour is called for. A correction is needed.

# Surficial Features and Rock Fragments

surface morphological features such as "vesicular crusts", desert pavement, shrinkage-cracking, and micro-sites for seed germination should be described for range and forest soil application. A future committee should consider appropriate terminology.

# Need for Expanded System Manual

An expanded manual is needed to explain and illustrate the site-description terminology called for in this report. It should be useful both for sampling pedons in the field, for pedon data users, and perhaps in the future for updating the valuable and extensive, existing pedon data bank.

#### APPENDIX 1

Landform Terms from the 1987 Version Of a National Pedon Coding System, and Physiographic Terms in the "1979 Pedon Codinging System for the National Cooperative Soil Survey"

#### Note:

- Terms in the original, 1979 Pedon Coding System.
- Terms that were in the original 1979 Pedon Coding System but have been deleted or revised in the 1987 version of the new national pedon coding system.

MAJOR LANDFORMS: (Categorical Level 1; "REGIONAL PHYSIOGRAPHY" Of 1979 Version of the pedon coding system.):

Badlands
Bolson
Coalescent Fan Piedmont
Drumlin Field
Foothills
Glaciated Upland \*
Hills \*
Lake Plain \*
Lava Plain
Mountain Valley

Barrier Island
canyon
Coastal Plain •
Deeply Dissected Plateau
Glaciofluvial Landform \*
High Hills \*
Karst Plain
Level or Undulating Upland \*
Mountains

#### LOCAL LANDFORNS: (Categorical Level 2)

Alluvial Fan Alluvial Flat (Plain) Beach Barrier Flat Bog \* Backswamp Beach Terrace Butte Carolina Bay Cove crater Cuesta Delta Dome Drumlin \* Dune Esker End Morain Escarpment • Pelsenmeer Flood Plain • Fluvial Terrace Fiord Ground Morain Hogback Hillside Kame Kettle Low Sand Ridge Lake Terrace Marsh Mesa Mountainside Marine Terrace Outwash Plain Outwash Terrace Oxbow Pediment \* Playa Ridge Structural Bench Sink Salt Marsh \* Slough swamp Volcanic cone Valleyside # Fan, Colluvial or Alluvial (includes a fan of a piedmont slope) # Cuesta or Hogback # Dome or Volcanic Cone # Broad Plain (includes Outwash and till plains and coastal flats) # Crater (includes sinkholes and pits) # Cuesta or Hogback # Dome or Volcanic Cone # Broad Plain (includes Outwash and till plains and coastal flats) # Crater (includes sinkholes and pits) # Abandoned Channel (includes oxbows, sloughs, and backswamps) # Hillside (includes a mountainside) # Moraine # Kamefield (includes kettles and eskers) # Mesa or Butte (includes a bench) # Low Sand Ridge, nondunal (includes natural levees, beaches, bars, or spits # Playa or Alluvial Flat # Upland Ridge # Sand Dune or [Sand] Hill # Terrace, stream or lake # Terrace, outwash, marine, or fan (truncated) # Swamp or Marsh (peraguic moisture regime) # Barrier Bar # Backbarrier Flat

#### APPENDIX 2

A Tentative Re-Sorting-Out of LANDFORM Terms from the list of "Shape-Form-Position" Terms in "NSH Part 607" into Categories

Terms shown in **boldtype** are not in NSH Part 607.1

I II III ΙV VI Gross Major Major Component Landform Slope Part Form Landform Landform Element component

[BOTTOM-TWO CATEGORIES TO BE APPLIED TO

EROSIONAL LANDFORMS: ]

"Interfluye"2 Headslope Sideslope Noseslope

Partial Ballena

Crest/Summit4 Shoulder Backslope Footslope Toeslope

**MOUNTAIN** 

Peak Ridge

Saddle

spur

canyon

Faceted Spur

Talus Landslide

Cliff

Avalanch Chute 5 Ledge

Alpine Mountain

Horn Arete Cirque

**Headwall** 

Col

Lateral Morain Valley Train

Caldera

Volcanic cone

crater

volcanic Flow / Basalt Flow / Rhyolite Plow

Mesa

10

I II III IV V VI

Major Major component Landform Slope

(?) Part Landform Landform Element component

"ILL (variously < 300 m or < 1,000 ft. high)

Ridge

Landslide

Foothill
Butte
Cinder Cone
Cuesta
Hogback
Mesa
Dome
Inselberg
Knob
Knoll
Nunatak

PIEDMONT

Pediment'

PLATEAU

Mesa Tableland Lava Plateau

Lava Plain

Steptoe

Scabland

PLAIN

Pediment'

COASTAL PLAIN

Pediment\_10

Fen

11

v VI Ι II ΙV III Landform Slope Major component Major Element Component Landform (?) Part Landform TILL PLAIN Disintegration Morain Terminal Morain Recessional Morain Ground Morain Kame

Kame Terrace

Esker Drumlin Outwash Plain

Valley Train

Kettle

Kettle

RIVER VALLEY
Valley Floor

Floodplain

Channel

Point Bar Knickpoint

Braided Channel Natural Levee Valley Flat Backswamp

Floodplain Splay

Meander
Meander Belt
Slough
Oxbow Lake

Bog Swamp

Valley-Border Surfaces

Terrace

Stream Terrace
Alluvial Terrace
Strath Terrace
Structural Bench

Pediment

Bluff

Ι ΙI III ΙV V VI Landform Major Major component Slope (?) Part Landform Landform Element Component  ${\tt BOLSON~/~SEMI-BOLSON}^{14}$ Piedmont slope Mountain-Valley Fan Rock Pediment / Pediment 15 Ballena Alluvial Fan Fan Collar **Erosional Fan Remnant** 17 Fan **Piedmont** 18 Erosional **Fan** Remnant 19 Inset Fan Nonburied Fan Remnant Fan Apron Fan Skirt Bolson/Semi-Bolson Floor Channel Alluvial Flat Basin-Floor Remnant Alluvial Plain Lake Plain Lake-Plain Terrace Sand Sheet Dune Field Dune<sup>20</sup> Parna Dune

Axial-Stream Floodplain

Axial-Stream Terrace Beach Beach Plain 24 Offshore Bar Lagoon Floodplain Playa Playa

I II ΙV v III VI Landform Element Major Major Component Slope Part Landform Landform component SHORELINE

Reef Beach

Wave-cut Platform Wave-built Terrace

Swash zone

Berm

Beach Ridge Barrier Flat

spit

Beach Terrace Barrier Beach

Bar Lagoon Mud Flat Tidal Flat Salt Marsh Foredune

Marine Terrace

Delta

Barrier Island Carolina Bay

Estuary Fjord

Headland

Terms in 1987 list of landforms that are not in NSH Part 607 "List of "Shape-Form-Position Terms":

"Major Landforms":

Drumlin Field
Glaciofluvial Landform

High Hills Lava Plain

Volcanic Mountains

Deeply Dissected Plateau

Glaciated Upland

Level or Undulating Upland

Sandhills

"Local Landforms":

Felsenmeer Low Sand Ridge Outwash Terrace Fluvial Terrace Mountainside

Sink

#### Footnotes:

The "landform element/slope component" categories of Peterson (1981, Landforms of the Basin & Range Province Defined for Soil Survey, Nev. Agr. Exp. Sta. Bul. 28) together are at essentially the same categorical level as the "geomorphic component" of certain midwestern geomorphologists and the 1979 Pedon Coding System manual.

The latter defines the geomorphic component as a part of a hill or mountain identified by two characteristics: (1) its position either on top of the hill or mountain ("interfluve"--a poor term, should be "crest" or "summit"), at the head of a drainageway between two ridges (headslope), along the side of a ridge (sideslope), or at the end of the ridge (noseslope), and then after that position is identified, it is subdivided into (2) slope components: summit, shoulder, backslope, footslope, or toeslope. The "interfluve" is allowed only summit and shoulder components by the 1979 Pedon Coding System, and the headslope, sideslope, and noseslope are allowed only shoulder, backslope, footslope, and toeslope components.

Such an analysis can be applied to both very small and very large landforms that have been formed by, or affected by erosion. But it requires some common sense in application, e.g., a circular hill would have sideslopes, not "noseslopes." Nor does the concept, as written, allow for distinction between a very narrow, sloping hill or mountain tops (the crest of some writers), versus broader, flattish top (the summit of some writers, because only the term "summit" is used.

In later versions of the pedon coding system (1987), this "geomorphic component" concept has been split into what effectively are two categories, with the geomorphic component term being applied to only the interfluve-headslope-aideslope-noseslope distinction, whereas the summit-shoulder-backslope-footslope-toeslope distinctions have become "slope components."

- The term "interfluve" is the 1979 Pedon Coding System's poor choice for a name for the top of a hill or mountain. Crest and **summitare** preferable choices for narrow and wider hill or mountain tops.
- "Cove" is a regional synonym for particular headslope areas of mountain or hill valleys.
- The terms crest or summit need to be repeated in both the Landform Element (V) and Slope Component (VI) categories as names for narrow or wide hill or mountain tops; it makes no sense to have different terms for the two categorical levels. The following terms shoulder, backslope, footslope, and toeslope are the real "hill-slope" components.
- 5 "Avalanch chute" and "avalanch track" apparently are synonymous.
- Many geomorphologists now recognize that the erosion surface called a pediment can be cut across either bedrock or alluvium, and "se the simple term "pediment" for erosion surfaces cut across alluvium, whereas those cut across bedrock are called "bedrock pediment." This convention is followed here.

- Hawly & Parsons (1984, Glossary of Selected Geomorphic Terms for Western Soil Surveys, West Natl. Tech. Center, Scs, Portland) have plateaus and mesas as varieties of tablelands, but condsidering the great size of the Colorado and Columbia Plateaus, and the common, moderate or small "tableland" areas of the western USA, they have the order of generality reversed.
- 8 Alluvial Cone: a small alluvial fan, a "fanlette".
- 9 A commonly used synonym for fan **remnant** is "fan terrace."
- More-or-less synonyms for fan **piedmont** are coalescent fan **piedmont, bajada**, alluvial fan. The latter two terms are used for such a variety of fans that they are almost meaningless.
- $^{11}$  Dunes are subdivided into  ${\bf barchan}\,,\,\,{\bf seif}, {\bf and}$  transverse types by shape.
- $^{12}$  Parna dunes are composed of sand-sized clay aggregates rather than sand.
- $^{13}$  Only on semi-bolson floors.
- Only on semi-bolson floors. Alternative term: Alluvialterrace.
- Mis-defined in NSH Part 670; a plain on the floor of a **bolson** comprised of off-shore beaches and intervening lagoons.

#### APPENDIX 3

A Tentative Re-sorting-out Of Variously Listed MICROTOPOGRAPHIC Terms and Terms for MINOR LANDFORMS from the list of "Shape-Form-Position" Terms in "NSH Part 607"

[Note: terms in bold print not in NSH Part 6071

Bar and channel

Catsteps / terracettes / sheep tracks / cattle tracks

Coppice / coppice dume / coppice mound

Intercoppice / coppice bench & microplain & playette

Patterned ground / frost polygons / nets / stripes / garlands / steps /

stone net / sorted polygon / stone polygon

Thermokarst / thermokarst lake

Gilgai / microknoll & microbasin / microridge & microvalley

Hummock

Mound / Mima mound

Swale

Swell and Swale

Ping0

Solifluction lobe

Tank

# NCSS-UPC

# committee 6

# Laboratory Procedures

William R. Allardice, Chair, University of California, Davis

M.A. Fosberg, University of Idaho, Moscow

R.D. Heil, Colorado State University, Ft. Collins

Herb Holdorf, USDA Forest Service. Missoula, MT

Robert Klink, BIA, Phoenix, AZ

Warren Lynn, SCS, Lincoln, NE

W.D. Nettleton, SCS, Lincoln. NE

Chien-Lu Ping, University of Alaska, Palmer

# Western Regional Work Planning Conference of the National Cooperative Soil Survey Portland, Oregon June 23-27, 1986

# Report of the Laboratory Methods Subcommittee to the Steering Committee

# **Review of charge (continued from 1982)**

- 1. Review current methods of soil analysis with respect to their effectiveness in identifying soil properties.
- 2. Evaluate new methods of soil analysis and make recommendations to the Western Regional Work Planning Conference.
- 3. Communication problems and solutions to problems encountered in soil characterization analyses.
- 4. Establish minimum standards for laboratory procedures.

#### **Additional Recommendations**

- 1. Review selected literature and compare analytical procedures. Report findings to the steering committee.
- 2. Exchange soils with cooperating agencies and determines the variability.

# Response

- 1. Three 'types of analytical procedures were selected for review: extractable cations, cation exchange capactiy and texture (pipette for clay). There are several popular ways to analyze for cation exchange capactiy. The selected methods were sodium acetate pH 8.2, ammonium acetate pH 7.0, and sum of cations (extractable cations + exchange acidity by barium chloride pH 8.2). See appendix (1).
- 2. Soil samples were solicited from more than 40 locations. Early' on, twenty four researchers indicated interest in the project. We are fortunate to have fifteen researchers currently interested in the project and eight active. Progress has been slower than expected. The Southern and Eastern participants have indicated

TO: Chemistry Committee

FROM: W. D. Nettleton

SUBJECT: Calcareous Samples-Reporting of Data

We still have some problems with reporting BS and extractable cation data for samples that have 0.5 % or more of CaC03 eq., The current thining has been to report those data (ExtCa++etc) if the samples contain 1 % or less of CaC03.

I suggest the following: If of bases ext with NH40Ac exceeds CEC7 and there are traces or more of CaC03,

- (1) Delete NH40Ac ext calcium from the data sheet for those horizons.
  - (2) Delete of bases for the same horizons.
- (3) Delete CEC, of cations method for the same horizons
- (5) Report BS, NH4)Ac method, as 100% for all thiese horizons that contain carbonates.

I would make an exception for Ap horizons that contain lime but are underlain by horizons that are lime free. I would report all data for these Ap horizons.

I get nervous **aabout** Ext AC and BS, also when the Ext AC values get low. How good are these data. Would we do better to report only those horizons where Ext AC exceeds 1.0 **meq/100g** of soil? Then **we couldd** report those with less than 1.0 as traces and leave the BS blank.

16 to 10 æ.

DECISION SUPPORT SYSTEM FOR AGROTECHNOIAGY TRANSFER West Technical Soil Survey Work Planning Conference 13-17 June 1988

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The Decision Support System for Agrotechnology Transfer or DSSAT is a computerized methodology that consists of a data base management system, crop simulation models, expert systems, and application programs. It is a product of the collaborative efforts of many involved in the IBSNAT Project.

The International Benchmark Sites Network for Agrotechnology Transfer or IBSNAT Project is a prototype global collaborative research network coomposed of scientists and decision-makers from developed and developing countries. The purpose of the IBSNAT Project is to increase the efficiency of research in the tropics and subtropics by utilizing the technology of the information age to best apply our understanding of agricultural systems. They are a multi-disciplinary group representing national, regional, and international agricultural research organizations.

#### Crop Models

When the project began, IBSNAT collaborators identified 12 food crops for model development (see Table 1); all of which have been developed or are now in the developmental phase. Because no single institution or organization could achieve this monumental task alone, many have contributed to the effort, with researchers from USDA/ARS, Temple Texas, Michigan State University, the University of Florida, and the International Fertilizer Development Center providing leadership roles. The IBSNAT models are mathematical models that mimic the development and growth of a biological system on a daily time step. In order to fully justify the use of these models on a global scale, data sets were required to calibrate and validate model outputs.

This requirement led to the establishment of a standard minimum data set of specified site, management, weather, and experimental data necessary to run a crop model(IBSNAT Project, 1984). Collection procedures for weather and **phenological** data were outlined for interested participants, and data sets from each site include climate and soils information.

Data Base Management System

A microcomputer-based relational data base management system (DBMS) was used to store and retrieve the minimum data set for input into the crop models. During this first phase of the IBSNAT Project, IBSNAT recognized that standardizing the input/output formats of each data file in the DBMS would eliminate the need to develop a multiple array of retrieval programs for each model.

Thus, input formats of existing crop models were modified to conform with the output format of the DBMS. And models now under development are being programmed with a similar structure. The result is that any of the IBSNAT crop models can access any of the soil and weather data stored in the DBMS. The format for each of the data files is documented in Technical Report 5 (IBSNAT Project, 1985).

IBSNAT Outputs

Major outputs of the IBSNAT project include (1) the establishment of an operational data base management system and (2) the development of crop models that are transportable and global in application. The utilization of these outputs, however, requires the development of a delivery package or product manageable by the user for agrotechnology transfer. That product is the DSSAT and it provides the necessary interactive linkage between the information sources or data bases and the crop models. (Figure 1)

Crop models, expert systems, and application programs in the DSSAT are decision aids which are designed to assist policy makers, researchers, teachers, and extension personnel in evaluating alternative crops, cultivars, and management strategies to attain objectives specified by the user. The DSSAT utilizes existing knowledge to allow a better understanding of agricultural systems that will enable the user to predict performance and control outcomes.

# DSSAT Program

The first release of DSSAT, Version 2.1 by IBSNAT will contain four crop models, a strategy evaluation program, one expert system, data base structures for climate, soil, and crop data, and programs to facilitate the linkage of these components. (Figure 1)

The software requires nearly 9 megabytes and runs best if installed on a microcomputer system with a hard disk, 640 K RAM, and a math co-processor.

To utilize the DSSAT software effectively, the following data resources need to be organized.

•Genetic coefficients of cultivars to be grown;

-Historic weather data of solar radiation, rainfall, maximum and minimum air temperature; and

\*Soil characterization and classification data.

Earlier emphasis was placed on standardizing only crop and weather data (Technical Report 1, 1984, 1985, 1988) but a uniform and standard method of storing and retrieving soils information was also needed.

Soil Data Base Management System

With the recognition of <u>Soil Taxonomy</u> as the de facto international reference system, the National Soil Survey Laboratory of the Soil Conservation Service (NSSL/SCS) was recognized as the principal soils laboratory. Consequently, it became the primary source of soil survey reports containing laboratory analysis, profile description, and classification of soils from the United States and many foreign countries. Those from foreign countries were generated largely through the efforts of the Soil Management Support Services (SMSS) project, a program of the Bureau for Science and Technology, U.S. Agency for International Development implemented by the SCS.

The use of Soil Taxonomy requires analytical laboratory determined data sets to properly key out diagnostic properties. These standard analyses are well documented in Soil Survey Investigations Report No. 1 entitled "Procedures for Collecting Soil Samples and Methods of Analysis for Soil Survey." singular purpose of these analyses was to classify soils, much of the information contained in the soil and site descriptions and the data analytical sets are valuable for the management of agricultural systems. Soil survey reports produced by the National Cooperative Soil Survey (NCSS) contain a subset of the data The complete soil/site descriptions and analytical data collected. set are reported in the Soil Survey Investigations Report series produced by the SCS.

The soils information stored at the NSSL currently serves as the principal soil data base for all soils surveyed in the U.S. and its territories and contains approximately 700 pedons from various foreign sites. These latter pedons were sampled and characterized by SCS staff on TDY with principal support from USAID/S&T through SMSS for forums on Soil Taxonomy and Agrotechnology Transfer and for International Soil Classification workshops/conferences in different parts of the world.

A data base is functional and operational only if information can be stored and retrieved as needed. A standardized data file structure and common input/output formats for data entry and retrieval are required to maintain the integrity and stability of the data base. If all of the NSSL data sets and files are coded properly, i.e., SCS pedon coding system or a relational data base scheme, appropriate information can be retrieved for use in many different applications. These can range from crop simulation and geostatistical models to expert systems to geographical information systems. These application programs and the soils data base are decision aids to user groups. These user groups will need to

identify their data requirements, and their program structure will need to be interactive with the data base.

The value of these decision aids will be limited if its format

and that of the data base are not compatible.

At the national level, the NCSS passed out questionnaires at the West Regional Soil Survey Work Planning Conference to consider the content of a proposed NCSS database to be known as the National Soil Characterization Database. A NCSS committee will meet in Lincoln Nebraska from July 25 to 29, 1988 to consider the responses to the questionnaire.

It is hoped that the data inputs or contents will be opencontain as a minimum all of the information generated during a soil survey, and serve as the primary soil data base. An important question is "How will the data base be organized so that By defining the soil data file structure, developers of crop and soil models, expert systems, and other applications, such as geographical information systems, can now tailor their software to link into this structure. (Figure 2) This helps provide an "open architecture" for the DSSAT and will possibly allow other cropsoil models to fit into the system.

The SMSS program has been successful in promoting the use of Soil Taxonomy as the primary international reference system. Soil Taxonomy is defined as a basic system of soil classification for making and interpreting soil surveys. The role of SMSS now lies in its ability to utilize this basic system in addressing land use and soil management issues.

The availability and accessibility of soils data from an operational data base management system will permit SMSS and its user group to more fully utilize a range of decision tools or aids.

# DSSAT Applications

The DSSAT has been designed to allow users to adapt it to their own crop, soil, and climate conditions. As such, it serves as a framework for users to input their own soil and weather data, their own experimental data for validating the models, and their own weather generator coefficients for conducting long-term risk analysis and yield stability analyses. The DSSAT can then help the user to choose crop, cultivars, or management strategies by answering "what if" questions quickly and without benefit of costly field trials.

What if the traditional maize cultivar were replaced by a new promising cultivar? Would the new cultivar performed as promised? What if the plant density or planting date were changed? What if fertilizer rates were increased? If production varies with plant density, planting date, and fertilization, what density, planting date, or rate of fertilization should the grower choose to maximize profits?

With the DSSAT, answers to these questions can be obtained as quickly as the computer can process information. Today's microcomputer can generate, in less than a minute, information that would require one year of research by several scientists and technicians. In a few hours, DSSAT can generate a volume of information equivalent to that produced by a scientist in a lifetime.

#### DSSAT Validation

How reliable is the information generated by DSSAT?

No user should leave this question unanswered. If there is any doubt about the reliability of the DSSAT outputs, the user should conduct validation experiments to test the quality of the information produced.

The two components of the DSSAT that are most readily tested are the expert system and crop models. The expert system diagnoses problems associated with soil acidity and makes recommendations on alternative ways to overcome them. It also enables the user to

**assess** the economic outcomes of the alternative corrective strategies.

The crop models simulate growth, development, and yield of a crop. In doing so, the model must be able to predict the timing of critical growth stages, such as time of silking or flowering and date of physiological maturity.

Validation Experiment

A validation experiment requires the collection of a minimum data set consisting of soil, crop genetic, weather, and management information. The DSSAT will use the soil, weather, and crop genetic information to simulate crop growth and performance. Outcomes of the DSSAT are judged on the basis of how well its simulated results agree with observed results. If the DSSAT can mimic reality, the user can safely assume that the DSSAT can be used with a degree of confidence.

The DSSAT outcomes generated are based on many years of simulation. The results should differ from year to year because conditions such as weather vary from year to year. It assumes that the weather pattern for future years will not be dissimilar to that of previous years. A one-season validation experiment, therefore, is unlikely to give the same result as the mean value of a DSSAT experiment derived over a 30-year period.

These validation experiments should serve more than just a test of the reliability of the DSSAT, but they should give users the confidence needed to exploit the information generating power of the DSSAT.

The **DSSAT's** integrity and reliability are strengthened by users who are willing to question and test the **DSSAT's** capacity to give useful information quickly for timely decision making in the agrotechnology transfer process.

Table 1. Twelve food crops for which IBSNAT models have been developed or are being developed.

Cereals
Wheat
Maize
Rice
Sorghum
Millet
Barley

Grain Legumes Soybeans Peanut Dry beans

Root Crops Potato Cassava Aroids

Table 2. IBSNAT Soil Data File Structres.

Name	Type	Len	Dec	Description
********	====	#==	===	*******
File 1				
SOURCE	C	3	0	Source of particular profile
IDPED	C	7	0	Key Field
IDS17	C	9	Ď	Site information
LATSTR	C	7	0	Latitude
LONGSTR	C	8	0	Longi tude
TXORD	C	1	0	Taxonomy code, Order
TXSORD	C	2	0	Taxonomy code, Sub-Order
TXGG	C	2	0	Taxonomy code. Great Group
TXSGM	C	4	0	Taxonomy code. Sub-Croup Mod.
TXTEX	С	3	0	Taxonomy code, Texture
TXMIN	С	2	0	Taxonomy code. Mineralogy
ТХРН	C	2	0	Taxonomy code, Reaction
TXTEM	С	2	0	Taxonomy code, Temperature
ELEV	C	4	0	Site Elevation in meters
SLOPE	C	11	0	Site Slope characteristics
ANNA	С	3	0	Annual Air Temperature (°C)
ESPERM	С	1	0	Estimated Permeability
SDRAIN	С	1	0	Soil Drainage Class
ERWA	С	1	0	Erosion Information
DCOLOR1	С	10	0	Dry Soil Color (see SCS-\$01-232)
"COLOR,	C	10	0	Hoist Soil Color (see SCS-Sol-2321
File 2				
IDPED	C	7	0	Key field
BHDEP	C	3	0	Depth, Bottom of Horizon Section (CM)
MASTER_HOR	С	2	0	Master Horizon
CLAY	C	4	0	Total Clay (Note:
SILT	С	4	0	Total Silt Sand = 100 · Clay · Silt)
OC	C	5	0	的推步。据和李
N	С	6	0	
P	C	5	0	
P_METH	C	3	0	
FEDITH	C	5	0	
ALDITH	C	5	0	
"ND, , "	C	5	0	
CAX	C	5	0	
MGX	С	5	0	
NAX	С	5	0	
KY	С	5	0	
ALX	С	5	0	
SUMCAT	C	5	0	
CEC7	C	5	0	
BSESAT	С	5	0	
ALSAT	C	5	0	
PH1H2O	C	4	0	
CACO3	C	4	0	
CACO32	C	4	0	

Name	Туре	Len	Dec	Description
	====	222	===	22222222
WCSX	С	5	0	Magnesium Content Saturation Extract (H2O)
ECSX	c	5	0	Electric Conductivity Barium Chloride
PHNAF	C	4	0	pH, 1:50 Soil-NAFL Suspension
PNKCL	С	4	0	pH, 1:1 Soil-KCL Suspension
PSORP	С	4	0	Phosphorus Absorption
PSORP_METH	С	3	0	Phosphorus Absorption Method (def. = 0011
TKHFD	C	6	0	Total Potassium (MF Digestion)
D3	С	5	0	Sulk Density, 113 bar
DOD	С	5	0	Sulk Density, Oven Dry
WP10	С	5	0	1110 Water Clods
WP3	C	5	0	1/3 Water Clods
W15AD	C	5	0	15 Bar Air Dry Soil
TCFRAG	С	5	0	Total Coarse Fragments > 2 MM Weight %)
STRUCT1	C	6	0	Soil Structure
CONSDRY	C	3	0	Soil Consistence Dry
CONSMO	C	3	0	Soil consistence Moist
CONSOT	С	3	0	Soil consistence Other
ROOT 1	С	5	0	Root information (quantity. size)

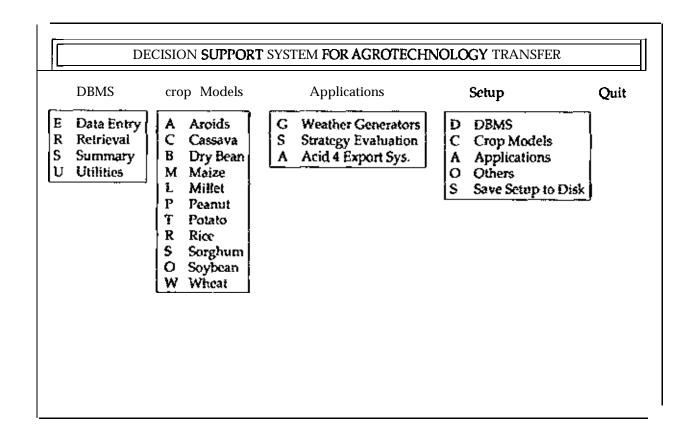
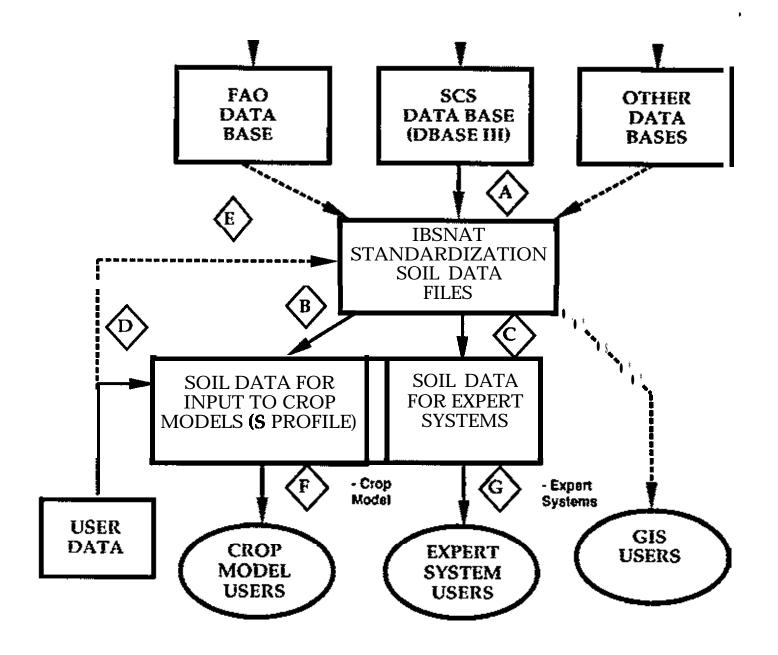


Figure 1. Components of the IBSNAT decision support system for **Agrotechnology** Transfer.



# PROGRAMS:



- Program to take SCS Data, check it, enter data into IBSNAT STANDARD DATA Files. Perhaps some data would be estimated.



# THE IMPORTANCE OF SOIL CHARACTERIZATION IN STUDIES OF RHIZOBIUM ECOLOGY Western Regional Soil Survey Work Planning Conference June 13-17, 1988

Pen Bohlool, Paul Woomer and Janice Thies
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The University of Hawaii's NifTAL Project (Nitrogen Fixation by Tropical Agricultural Legumes) is a USAID and National Science Foundation sponsored program whose goal is to optimize biological nitrogen fixation (RNF) and improve the use of Rhizobium in developing countries. This is accomplished through outreach, training and research. An important component of this research is to select rhizobia that persist in tropical soils between the cropping cycles of legume hosts. The island of Maui offers excellent opportunities to conduct ecological studies of beneficial soil microorganisms through the MauiNet [Maui Soil, Climate Land Use Network (Ikawa et al., 1985; SCS, 1972, 1984)].

To assess environmental factors that influence the survival of introduced rhizobia, eighteen strains of rhizohia which are used as inoculant with legumes throughout the world have been released at 14 MauiNet sites. A total of 27 million rhizobia ware released per site. These sites range in rainfall between 325-1875 mm/yr and are characterized as Haplustolls, Andepts, and Tropohumults. Ore year following introduction of the

The applicability of the results from experiments conducted on Maui to other parts of the tropics is presently being tested through the World-wide Rhizobial Ecology Network (WRFN). Member scientists from 19 nations are linked through their interest in the ecology of rhizobia in tropical soils and their desire to see a predictive model of legume response to inoculation constructed and verified. WREN members are conducting a standardized set of laboratory, greenhouse and field experiments using legume species of economic importance in their countries.

In conclusion, we have found that soil classification serves as a useful indicator of the ecological relationships in soil. Significant regression models have been developed which describe the natural populations and the success/failure of introduced populations as determined by soil conditions. The most important of these conditions are soil moisture, soil water holding capacity, total organic carbon, CEC arid total extractable bases. Furthermore, the number of native soil rhizobia coupled with soil N availability have teen shown

# IDENTIFYING AND USING ALTERNATE DATA SOURCES TO SUPPLEMENT NATIONAL RESOURCES INVENTORIES \*

#### INTRODUCTION

This paper focuses on identifying and making better use of alternate data sources that can supplement the Soil Conservation Service's (SCS's) National Resources Inventories (NRIs). This includes discussion on:

- 1) determining the needs of the users of resources inventory data,
- 2) identifying other existing data sources that can effectively supplement the NRI data, and
- 3) expanding the utility and utilization of the NRI and supporting data.

# DETERMINING THE DATA NEEDS OF USERS

An important step in identifying appropriate sources of data to supplement the NRI is to determine the kinds of information most needed by the data users. Within SCS, resource data for assessing conservation policy and program needs has the highest priority; i.e. information that addresses the status, condition and trends of the nation's soil, water, and related resources in relation to SCS programs. Additional data needs are considered through interests expressed by other agencies, researchers, educators, and special interest groups etc.

Looking at data collected by SCS in the past provides some insight regarding the agency's resource data needs. Based on the NRIs conducted by SCS to date, (the 1977 and 1982 NRIs and the nearly completed 1987 NRI) some of the more common data categories are as follows:

- surface area and land cover/use
- land capability
- conservation treatment needs.
- soil erosion
- potential cropland
- prime farmland
- pastureland and rangeland conditions
- saline and/or alkali areas.
- floodprone areas
- \* Presented June 16, 1988, by Keith O. Schmude, Soil Scientist, Resources Inventory Division, SCS, NHO, at the Western Regional Cooperative Soil Survey Conference, Maui, Hawaii.

The above list of data categories does not include all the data collected during the NRI process. It only includes some of the "basic statistics" as published in United States Department of Agriculture (USDA) Statistical Bulletins numbered 686 and 756 for the 1977 and 1982 NRIs respectively. The overall data files for the NRIs contain additional information. For example, the 1982 NRI, one of the most comprehensive studies of the United States' natural resources ever conducted, has been condensed into a data file containing 841,860 records covering about 75 data file fields or data categories. The somewhat more limited, soon to be completed 1987 NRI is an update of the 1982 NRI and is designed to provide trend data for the 5-year 1982-87 interval.

As comprehensive as the NRI data are, they do not meet all the resource information needs of USDA, SCS, and others interested in resource conservation policy and programs.

#### IDENTIFYING OTHER EXISTING DATA SOURCES

Because of the increasing demand for more comprehensive and complex resources data, and because of the high cost of collecting these data, there is a growing need to make better use of alternate data sources that can supplement the NRI. This is especially true with the increasing use of complex computer models for data analyses.

An important aspect of the NRI is that it provides for integrating data such as soils, land capability, soil erosion, and aspects of land cover and management etc. This integration capability, showing the relationship of one resource to another, significantly increases the potential for expanding the use of the NRI data for various analyses.

Likewise, linking or integrating the NRI data with other data sources can increase the utility of all the data involved. To consider many of the sources of resource data available throughout the country will require involvement at all levels ranging from local governments to national level agencies.

In order to explore possibilities of collecting and sharing data at the local as well as the national level, the Resources Inventory Division is now working with states to fund "Inventory Development Activities" designed to explore ways to meet future data needs. For example, activities to meet information needs on water quality are now underway that involve other agencies and groups. This involvement ranges from working with local people interested in health

and property values, to coordinating with Federal agencies representing national interests. Such cooperative interaction with others should provide opportunities to link the NRI data with other existing data or to merge other data into the NRI.

The following table, extracted from an ongoing water quality inventory development project (being funded in part with Inventory & Monitoring funds), illustrates the broad based cooperation necessarg for addressing complex issues such as water quality.

INVOLVEMENT

CNITITY

<u>ENTITY</u>	INVOLVEMENT
Homeowners	Interest in health and property values
Local Business	Interest in water supply and future economic health
Cities and Villages	Provide continued water supply
County	Protect public health, provide zoning protection and service conservation programs
State Department of Natural Resources	Monitors water quality and regulates groundwater protection law
State Department of Agriculture	Regulates pesticide <b>use</b> and trains pesticide appliers
Ctata Eutamaian	Provides water quality education and develops best management practices
State Geological & Natural History Survey	Maintains geologic information
U.S. Environmental Protection Agency (EPA)	Provides national water quality leadership
USDA (Forest Service and SCS)	Represents agriculture and protects land and water resources

The first phase of the developmental project described above will determine how agricultural activities impact on groundwater. This will involve merging existing data that can be related to water wells (domestic well sampling, soil surveys, well construction records, land use and zoning, annual land cover, high capacity wells, buried tanks, barnyards, land fills, etc.) into a single database and converting all the informational layers to be used in the project into a PC-ARC/INFO format. This local exploratory project may be a forerunner to inventories carried out on a national scale for assessing groundwater pollution problems throughout the country.

In addition to exploring possibilities involving state and local people in identifying alternate sources of data to supplement the NRI, identification of various databases to support the NRI are being considered at the national level. As part of a strategy session, involving key technology people at NHQ to explore development of a Geographic Information System (GIS) for use at NHQ, a list of existing databases was produced. The list was separated into two categories including attribute databases and spatial databases as follows:

Attribute Databases (in addition to the NRIs)

- 1. 1982 Frozen Soil Interpretation Records
- 2. State and County Names
- 3. Place Names

# Spatial Databases

- 1. National Soil Geographic Database (NATSGO) 1:7.5 million scale
- 2. State and County Boundaries 1:7.5 million scale
- 3. Hydrologic Unit Boundaries
- 4. Transportation
- 5. Hydrology
- 6. Soil Survey Area Boundaries
- 7. Congressional District Boundaries
- 8. SCS Activities Map Boundaries
  - a. Resource Conservation & Development Areas
  - b. Watershed Project Areas
  - c. Great Plains Conservation Program area Boundaries
  - d. Soil and Water Conservation District Boundaries

- 9. Land Use
- 10. Kuchler Cover Type Map
- 11. Forest and Range Ecosystem Map
- 12. All 1:2 million U.S. Geological Survey (USGS)
  Digital Line Graphs (DLG's) for planimetric data
  - a. boundaries
  - b. transportation
  - c. hydrography
  - d. U.S. Public Land Survey System

As mentioned earlier in this section on identifying other existing data **sources** to supplement the NRI, making maximum **use** of such data requires coordination at all **levels** of government. This includes coordination among federal agencies responsible for activities and programs at the national level. This need for coordination was **recognized** nearly a decade ago when, in October **1978**, five federal agencies signed an "Interagency Agreement Related to Classifications and Inventories of Natural Resources".

The five agencies involved, having major responsibilities in dealing with the Nation's natural resources are; the Bureau of Land Management, the Fish and Wildlife Service, the Forest Service, the Geological Survey, and the Soil Conservation Service. The purpose of this agreement is to minimiee duplication and overlapping efforts and to enhance and encourage overall data collection, data eharing, appraisal efficiency, program compatibility, and expedite technology transfer.

The interagency agreement resulted in the assignment of several task forces to look at possibilities for interagency coordination on classifying and inventorying natural resources. Among the assignments was the charge to address land cover categories which became the forerunner of the "Earth Cover Identification" system now being tested by the Forest Service and SCS. This effort should ultimately facilitate the sharing of compatible data. Another project under the five-agency agreement was the compilation of a directory of Inventories of Natural Resources as conducted by each of the five agencies. The directory describes, and gives agency contacts for 90 major inventories covering natural resources and resource conditions. Some examples of elements included are:

water, toxic substances, timber, wildlife, wetlands, range, fuels, endangered species, acid rain, soils, plant materials, minerals, petroleum, important farmlands, and many others too numerous to list here.

The interagency directory should serve as a useful reference in evaluating possible data sources to supplement NRIs.

#### EXPANDING THE UTILITY AND UTILIZATION OF RESOURCES DATA

In order to make maximum use of resource data, it is necessary to develop the proper tools. This includes developing data user packages, and developing a Geographic Information System at NHQ to facilitate integrating data from various sources. The SCS Deputy Chief for Technology at NHQ is initiating a strong program to accomplish these goals. The Resources Inventory Division is playing a major role in its implementation.

An important part of the present plan is to develop a computerized package that will enable SCS State and Area Office personnel to easily and efficiently analyze the results of the 1982-87 NRI by area or state by the time the 1987 NRI data is ready for release in early 1989. The recommended system for accomplishing this is a "user friendly menu driven" system developed for use on state and area office FOCAS equipment (i.e., AT&T 3B2 super microcomputer systems). This system would be capable of producing tabular reports and developing graphics.

In addition to the system to be developed for use on the FOCAS equipment, there is a desire to place the 1982-87 NRI data into a nationwide database management system. This would be designed to allow easy access to NRI data to all concerned users including SCS staffs at NHQ and other agencies or groups outside SCS.

A test is now underway that involves loading the NRI data (including the appropriate soils data) into an ORACLE database management system on the main-frame computer at Iowa State University (ISU). If the test is successful, SCS and ISU will consider a joint project to provide procedures and documentation for data users wishing to access NRI data at a national or regional level.

Finally, there is a need for a GIS to be used in doing a better job of integrating resource data from various sources. This would facilitate use of many existing sources of data for National Policy Analyses, for SCS's Conservation Programs, and for other purposes.

The ultimate goal is to have several Divisions at NHQ actively using such a system. An NHQ GIS project management plan has been prepared and approved. An order has been prepared for an NHQ ARC/INFO system. Also, additional staffing and realignment, including an ARC/INFO Operations Specialist position, is being considered at NHQ.

Once ARC/INFO is in place, many of the data sources outlined above can be considered for loading into the system. The NRI and **soils** data will have high priority, followed by existing ARC/INFO formatted databases from other sources.

#### SUMMARY

Determining high priority data needs of users, both within and outside SCS, is an important step in the process of building a system of related databases dealing with the status, condition, and trends of soil, water, and related resources. These data needs are increasing rapidly due to new resource concerns, especially as related to water quality and offsiteec ouncerns.

#### NATIONAL SOIL-RANGE TEAM

#### REPORT ON

# STANDARD SITE DESCRIPTION AND SITE CORRELATION PROCEDURES

In order to develop a common ground with all of you, we would like to present some background information of interest. A substantial portion of the effort put forth by the National Soil-Range Team (NSRT) to date originated with a previous committee (Ecological Site Correlation) that was an active part of the Western Regional Work Planning Conference in 1982 and 1984. Due to the overlap of committee charges and work assignments of the NSRT (i.e. develop site correlation procedures; develop ADP procedures and data storage for site correlation; identify organization and support functions for site correlation and develop an overall structure for site correlation efforts involving a multi-discipline approach) it was determined that the committee no longer served a useful purpose. As a result, the NSRT is to report back to this group, on a biannual basis, their progress in addressing the original charges.

As some of you already know, the NSRT has been intimately involved **with** the site correlation procedures and a standard site description since its inception in April 1983. The original charges given to the NSRT at that time are as follows:

- 1. Develop a set of procedures **that** will standardize site correlation and is compatible with current soil correlation standards.
- 2. Develop a Standard Site Description format that:
  - (a) has a standard set of data for entry and retrieval of resource information;
  - (b) can be consistently used and interpreted by the various disciplines (i.e. biologists, foresters, range conservationists, etc.);
  - (c) can be consistently used between agencies and other groups allowing for ease of data transfer.

These original charges as well as others are still pertinent today.

A number of draft documents were subsequently prepared, submitted for review, revised and were sent out again for additional review. This involved input from various sources **during** the reviewed processes such as:

- 1. BLM, FS, and SCS W.O. staff.
- 2. Extensions Specialists from the W.O. and various western states.
- 3. University academic community mainly in the west.
- 4. The NSRT Advisory Committee members.

It became apparent in the fall of 1985 that any further review of the draft documents would result in the revision of the revisions. During the winter of 1986, the National Soil-Range Team Advisory Committee net in the NHQ with the Associate Chief, SCS to request approval to test the proposed Standard Site Description and Correlation Procedures. Approval was granted for a field test in the states of CA, NV, UT and SD. In the spring of 1986, a briefing was held in Reno, NV to begin the testing phase. California was the only state approved to test the ecological site concept. Nevada and Utah were asked to test the procedural application for interstate correlation and correlation with other agencies where applicable. South Dakota was selected to test the correlation concept in a different geographical and administrative area. The target date for completion was the fall of 1987. Representatives from three of the four states also developed an Analysis Matrix. Ten criteria were identified as the basis for evaluation:

- 1. Improve efficiency for completing and updating site descriptions.
- 2. Establish site and interstate correlation procedure.
- 3. Facilitate ADP use.
- 4. Standardize **criteria** and concepts for descriptions, **classification**, and interpretation.
- 5. Enhance interagency/scientific community communications and coordination.
- 6. Adequately address ecozones and other plant communities. (This refers primarily to transitions from grasslands to shrublands to forests, not the ecotones between individual sites.)
- 7. Determine ecological status for all plant communities.
- 8. Require interdisciplinary input and evaluation.
- 9. Increase utility for planning and land user acceptance.
- 10. Use ecological principals for all inventories.

The four state (CA, NV, UT, SD) task group met in Salt Lake City, Utah in February, 1988 to **review their** individual state **findings** and complete a consolidated evaluation report. The results are as follows:

The criteria 1-5 and 8-10 were fully met or surpassed the expectations set forth. Criteria 6 and 7, that deals with **ecozones** and ecological status, till be addressed in the Interpretations Section when developed.

#### Time Requirements:

Initially, time requirements will increase until the procedure is learned and data accumulated; however, when the data retrieval system is established, efficiency of site correlation and site descriptions will increase and time requirements will decrease.

The Four State Task Group also made the following recommendations to the NSRT Advisory Committee as part of their evaluation report:

- 1. It is recommended to accept and institute as policy the Proposed Site Correlation Procedure.
- 2. **It is** recommended that the changes in this report be instituted in the Site Correlation Procedure.
- 3. It is recommended that needed changes in other handbooks (i.e. NSSH, NRH, NBH, NFH) be made as suggested.
- 4. It is recommended that the Standard Site Description be adopted as an instrument to describe all potential natural plant communities, as defined in the National Range Handbook.
- 5. It is recommended that the Standard Site Description Database (SITEFORM) be accepted and the SITEFORM and CAMPS have the ability to exchange common data and have the flexibility to accommodate the needs of individual states. It is further recommended that the FOSS team be responsible for coordinating with other user groups and agencies.
- 6. It is recommended that Soil Factors (Section 3) of SITEFORN and State Soil Survey database as used in CAMPS be designed to share common data.
- 7. It is recommended that SITEFORM be compatible with other database/operating systems, including UNIX.
- a. It is recommended that Range Site Descriptions in CAMPS be compatible with Standard Site description Databases.
- 9. It Is recommended that changes in the Standard Site Description as contained in Appendix E of the attached document **be** incorporated.
- 10. It is recommended that SITEFORM Part B: Interpretations be developed in a format compatible with Part A. It is further recommended that the National Soil-Range Team be responsible for development and field testing of Part B.
- 11. It is recommended that the Proposed Site Correlation Procedures be finalized and approved for immediate use in on-going Soil Survey throughout the West NTC area.
- 12. It is recommended that the Proposed Site Correlation Procedures be further tested in the marshlands of Louisians.

Description and **Siteform** Data Base Program. Upon completion of the revisions and at the request of SCS management, a presentation was made **in** May 1988 at Salt Lake City, Utah to the SCS, western states State Range Conservationists, Biologist, Foresters, and several State Soil Scientists. The purpose was to introduce and **familiarize** the participants concerning the procedure prior to implementation in the near future.

In brief, the Site Correlation Procedures address the following items:

- 1. Responsibility Assignment of responsibility from the Director, Ecological Sciences staff, SC'S, NHQ to the state conservationist or his designated representative.
- 2. Timing The scheduling and sequence of events from approximately six months to one month prior to correlation.
- 3. Procedures Internal consistency, **comparison** between sites, documentation required and preparation of reports.
- 4. Records of Site Descriptions Maintenance of field data and site record card files.
- 5. Updating or revising site descriptions.

The Standard Site Description and the associated **Siteform** Data Base Program (presently called Part A) address a number of site factors under the following broad headings:

- 1. Landscape Factors To include geographic location, physiography and associated water features.
- 2. Climatic Factors To **include** soil moisture and temperature regimes, annual air temperature, annual precipitation, frost free seasons, and monthly moisture and temperature distribution patterns.
- 3. Soil Factors Such as major soil families, geology, surface soil features, soil depth, root zone depth, AWC, zones of accumulations, soil profile, rock fragments, EC & SAR, monthly water states and water table.
- 4. Vegetation Factors Such as **foliar** cover and structure, vascular plant community and **cryptogamic** community.
- 5. List of Wildlife Species Species that use the site.
- 6. **Community** Dynamics Expected time **relationships** concerning natural disturbances.
- 7. Commonly Associated Sites List of 6.8 Tm ( List of ̥̍ñr. øo8

t of ̥̍r̂

8.

9.

Although it may sound like our work is finished with the Site **Correlation** Procedures, it becomes more apparent with each passing day that we have just begun. Our long term workload entails a variety of endeavors. The most prominent at present are:

- 1. Continue with refining the Standard Site Description and Site Correlation Procedures.
- 2. Prepare a draft user guide for the **Siteform** Program and associated query program.
- 3. **Assist** in implementation and further testing of the description and correlation procedures on a regional and national basis.
- 4. Prepare and refine site interpretations that are compatible with Part A of the Standard Site Description. The first draft was presented to the western states in Salt Lake City, with comments due back to the WNTC by August 1.
- 5. Start the development of a prototype data base for the site description interpretations.
- 6. As riparian core team members, we need to identify additional needs and format **revisions** to accommodate the Standard Site Description for use in wetlands and **riparian** areas.
- 7. Continue with our involvement in technology transfer.
- a. Continue with identifying and developing ADP links with present and future data bases as they apply to soil-vegetation correlation and interpretations leading to sound management practices.

As you can **see**, these are just a few major areas of our involvement. We are stressing soil-site correlation and use of the resulting data base as an integral part of future soil-vegetation management systems.

Attachments

Site Correlation Procedures
Standard Site Description Instructions
Standard Site Description (Part A)

#### SITE CORRELATION PROCEDURES

The formal site correlation procedures are designed to standardize and supplement part of Section 302.8 Naming and Correlating Range Sites of the National Range Handbook (NRH).

This procedure will also supplement the applicable sections of the National Biology Manual (NBM), National Forestry Manual (NFM) and National Soil Handbook (NSH) as appropriate.

The "Site Correlation Procedures" will establish compatibility with current soil correlation standards as set forth in the NSH. This is accomplished by providing site correlation with soil correlation from the start of field work through the formal correlation process. (See NSH Section 602.00-4).

Site correlation is a process for consistently relating ecosystem components within and between ecosystems perceived as having the same climax or potential natural vegetation. The site correlation process also provides quality control for consistent description and documentation of the ecosystem components as well as subsequent interpretations associated within the site.

**Wildland** (grassland, woodland, wetland, etc.) resource inventories are basically 'ecosystem inventories'. These ecosystems include not only vegetation and soil but also the associated climate, water, and animal life. Ecosystem components, including vegetation, soil, water, air, fire, animals, topography, temperature, solar energy, and man, are closely and completely interrelated. Any influences exerted on one affects the others.

In order for any site correlation process to proceed  $in \cdot a$  orderly manner, the following items need to be understood and addressed by all participants.

# 1. Responsibility

A. The Director, Ecological Sciences Staff, National Office, SCS, through the National Technical Centers (NTC's) has the responsibility for the correlation and establishment of sites.

The NTC Director will be responsible for correlating sites within his region and will maintain a file of all correlated sites by using a numbering system and retaining copies of all correlated site descriptions.

- B. State Conservationists will be responsible for maintaining a record of all sites within their state according to their status and for proposing sites to the NTC. State Conservationists in consultation with administrators of cooperating agencies will also be responsible for correlating all sites within their state. When a site occurs in more than one state, the NTC Director will designate the state responsible for maintaining and updating the site.
- C. Field personnel of all cooperating agencies will be responsible for collecting the necessary documentation for each site used and will propose draft descriptions as needed for further consideration and approval by the SCS State Conservationist.

#### 2. Timing

- A. Site correlation is a continuous process initiated at the beginning of any soil or vegetation survey and progressing through a final correlation (which may also include an interstate correlation).
- B. Site correlation is normally done in conjunction with soil survey correlation. However, site correlation may also be necessary because of updates or revisions to site descriptions.
- C. Preparation for intrastate and interstate site correlation should include:
  - (1) Six months prior to correlation:
    - (a) The states involved should communicate as the soil survey(s) progress to correlate common site descriptions. If there is disagreement on some sites, than a formal interstate correlation will be arranged.
    - (b) States involved will have exchanged proposed and/or established site descriptions for the area to be correlated.
    - (c) States will coordinate with field staff to jointly select locations to be correlated (it is not necessary to visit every site if there are no disagreements).
    - (d) States involved will document which sites can be correlated and those that cannot at this time.
  - (2) Three months prior to correlation:
    - (a) States will make an initial grouping or separation of sites based on the criteria in Part 3.B. of the site correlation procedures.
    - (b) States will submit a proposal to NTC for correlating comparable sites and/or resolving issues that remain.
  - (3) One month prior to correlation:
    - (a) States will have available all necessary documentation as outlined in Part 3.C., including soil pits at the review sites.

#### 3. Procedures

- A. <u>Internal consistency</u> site forming factors should be checked to insure compatibility within each factor and between individual factors.
  - (1) Entries for each individual factor should:
    - (a) Be representative of the site throughout its normal area of occurrence. e.g. Minor occurrence of the site in odd areas (landscapes, slopes, etc.) are not considered to be representative.

- (b) Accurately describe the site by portraying the narrowest range of characteristics feasible. e.g. In mountainous areas, elevation-aspect relationships may be important. Original entries may show the site on all aspects at elevations of 5,200 to 6,800'. The actual intent was for the site to be on north aspects at elevations of 5,200 to 6,400' and on south aspects at elevations of 6,400 to 6.800'. The original entries should be changed to reflect the elevation-aspect differences.
- (2) Entries for combinations of factors should:
  - (a) Be compatible between the range of characteristics described for each individual factor with other related individual factors. e.g. A common inconsistency is between the soil classification criteria and the climate factors.
  - (b) Be compatible between the plant species listed and soil landscape or climate factors. e.g. The presence of obligate wetland plant species are not common where the soil properties listed under the soil factors indicate the absence of a water table or other wetness characteristics.
- B. <u>Comparison between sites</u> Comparisons of site descriptions are made and documented when 1) new sites are proposed or 2) correlations are made between survey areas, MLRA's or states. The criteria used for making comparisons between sites are:
  - (1) Compare all sites that have two or more major species in common (10% or more composition by weight each) and/or that have the same soil family, groups of similar families or other taxons.
  - (2) For correlation purposes, initial guidelines for determining significant differences between sites will be:
    - (a) The presence (or absence) of one or more species that make up 10% or more of the potential natural plant community, as defined in the NRH, by air dry weight, or equivalent forest composition, by production (Site Index and volume) or cover.
    - (b) 20% (absolute) change in composition air dry weight between any two species in the potential natural plant community as defined in the NRH.
    - (c) Culmination of mean annual growth increment difference of 15 or more for tree species in forest or woodland sites.
    - (d) A difference in average annual herbaceous production of:

- (6) Wildlife Historical accounts, special studies, field observations, species list, etc.
- (7) General Field notes, photographs, etc.
- D. Preparation of Reports
  - (1) Field Review Checklist (Exhibit 1)
    - (a) To be completed by the responsible range conservationist or the designated representative as a supplement to soil survey area initial, progress and final field review reports. It is also applicable to internal site review processes.
    - (b) Intended to document the overall status and applicability of the site descriptions, vegetation support data and related actions within the soil survey area on an ongoing basis.
  - (2) Site correlation checklist (Exhibit 2) to be completed by the responsible range conservationist or the designated representative to document formal site correlation activities.
- 4. Records of Site Descriptions
  - A. Site description files containing complete site descriptions will be maintained by <u>Proposed</u>, <u>Established</u> and <u>Inactive</u> status. The file contents will include:
    - (1) Site Number
    - (2) Site Name
    - (3) Responsible State (As designated by the first two letters PIPS code for state abbreviations used in the standard site description number system)
    - (4) Status in the following format:
      - (a) Proposed site descriptions to be field tested for at least one year prior to consideration for acceptance. Files will be maintained by the responsible State Offices and NTC's. Proposed site descriptions will be identified with a (P) following the site name indicating its present status.
      - (b) <u>Established</u> site descriptions will be maintained by the responsible State Offices and NTC's. State Offices will maintain supporting documentation of the site descriptions.
      - (c) <u>Inactive</u> site descriptions will be maintained by responsible states.

- B. <u>Site record card files</u> will be maintained by the responsible NTC for tracking site status and actions.
  - (1) Contents will include:

Site	Number			
	Proposed	Author State	Approval NTC	Approval Date
	Established Revised			
		-		
	Inactive			
		Combined with	Site #	Name
			-	
		dropped becaus	e:	
				_

- (2) All users will be notified of any change in status upon approval by  ${\tt NTC.}$
- 5. Updating or Revising Site Descriptions

Site descriptions will be updated or revised according to procedures established in the National Range Handbook Section 302.10 (NRH-5, Feb., 1985).

#### Standard Site Field Review Checklist Date(s) of Review

(Use to Supplement Soil Survey Review Report For Internal Reports)

1.	Name of	f Area	(Including	county,	state	and	MLRA(s)	
			<u> </u>	· ·				

- 2. Level of detail for vegetative data (indicate range site, woodland site, habitat type, forest site, ecological site, riparian site, range condition or special studies).
- 3. Has soil survey memo of understanding been reviewed in regard to standard site management needs? Yes\_, No\_.1\_/
- 4. Do field party members have copies of sites descriptions being used? Yes\_\_\_, N  $_0$  \_ .1/
- 5. Is a site assigned to each soil compone of a map unit in the identification legend? Yes\_, No\_.19
- 6. Are all site descriptions written? Yes\_, No\_; Physical and biological characteristics: Yes\_, No\_; Interpretations: Yes\_, No\_.1
- 7. Does document on for each site support all soils correlated to the site? Yes\_\_\_, NO\_.1/
- 8. Field notes and other support documentation (how kept, by whom).
- 9. Are soil-plant relationships adequately described and documented? Yes, No. .1/
- 10. Is range of characteristics for the physical and biological characteristics of the site description adequate? (note kinds of deficiencies)
  - a. Landscape Factors
  - b. Climate Factors
  - c. Soil Factors
  - d. Vegetation Factors
  - e. Wildlife
  - f. Community Dynamics
- 11. Are interpretations for the site description adequate? (note kinds of deficiencies)
- 1/ Negative response should be explained under the appropriate question and/or addressed under item 16 noting the recommended actions, target dates and individuals assigned to complete objectives.

- 12. Do site descriptions of associated sites adequately separate one from the other? Yes\_, N o \_ .  $\frac{1}{2}$ /
- 13. Are exceptions to the modal concept described separately 7 Yes\_, No\_\_\_\_.1/ $^{1}$ /
- 14. Is vegetative data completed for SCS form 5's and 6's? Yes\_, No .1/
- 15. List of sites reviewed and status. (indicate soils correlated to each site during this review)

16. Deficiencies noted and recommended actions. (be specific and provide dates for completion)

17. Scheduled dates for completion of the vegetation inventory are compatible with the scheduled dates of the soil survey? Yes\_. No\_..1/

Date\_\_\_\_\_\_Signature\_\_\_\_\_\_

# site Correlation Checklist

1.	Nam	ne of Area(s):			
		e of Survey(s):	(County(s)	State(s)  I = soil and vegetation)	MLRA(s)
3.	Part	icipants:			
4.	Indiv	zidual Site Co	ntent		
4.		vidual Site Con			
4.	Indiv a.	vidual Site Con List sites rev			

c. Consistency and compatibility between factors – List sites with deficiencies and why deficient:

5. List competing sites to be compared during correlation and their status e.g. proposed (P) or established: (ref. Item 3B, pp. 3-4, Site Correlation Procedures)

6. List sites correlated, disposition and state responsible:

7. List sites dropped, or combined and subsequent disposition:

- a. Documentation availability (note deficiencies)
  - a. Acreage requirements:

]	b.	Field sheets, maps, etc.:
•	c.	Climate:
(	d.	Soils (series descriptions, Form 5's, 232's):
	e. <sup>1</sup>	Wegetation (417's, etc. and plant association tables):
:	f.	Wildlife:
;	g.	General (field notes, photographs, etc.):
9. F	Reco	mmended actions:
		e record card file completed(date)
Date _		

Signature(s)\_\_\_\_\_

# Instructions for Completing the Standard Site Description

#### Part A: Description of Site

Instructions for Part A of the standard site description provide a reference for each major entry. It is applicable to both the Site **Description** Form (Exhibit 1) and **Siteform** Computer Program. If data is not available at the time the description is being prepared, it should be left blank. Additional data can be added to the description and **siteform** program at any appropriate time. For the **Siteform** Computer Program, all alphabetical entries-should be made in upper case (capitals) to avoid confusion in database queries.

#### Heading

- <u>Number</u>: Sites are numbered consecutively within each Major Land Resource Area (MLRA) as shown in Agricultural Handbook 296. This assumes that a site occurs in only one MLRA or unit. Frequently, a site will occur in two or more adjacent MLRAs or units. When that happens, the site is recognized as an inclusion of one MLRA or unit in another, and will be numbered as a component of the MLRA or unit in which it is most extensive. A site number will occur only once within a state. The site number consists of characters (letters and numbers) in the following sequence:

#### EXAMPLE: 037XY005CO

- 1. The first four digits (037X) represent the Major Land Resource Area; If there is no capital letter in the MLRA use an X.
- 2. The letter (a,b,c, etc.) following the MLRA number represents a Major Land Resource Unit (MLRU). Use a Y when there are no MLRUs.
- 3. The next three digits (005 in the example) represent the individual site number. The site number will occur only once within a MIRA or MLRU.
- 4. The next letters represent the responsible state in which the site was described using two letters FIPS code for state abbreviations. The designation for other states that are also using the site should follow the responsible state letter designation.
- Name: Sites will be named two different ways depending on intended use.
  - 1. <u>Site Name</u>: Enter a common site name in the format traditionally used by the state (e.g. LOAMY **8-10" PPT).**
  - 2. Plant Name: Enter the species symbols for the potential or climax plant community. The plant species symbol should follow the convention of using a minimum of one overstory dominant species and an understory dominant species of the potential or climax plant community. Where codominants exist or where more than two layers of vegetation are found, additional symbols may be used. Layers are seperated by a "/"; codominants are separated by a "-". Thus a mountain big sagebrush stand with bluebunch wheatgrass understory should be shown as ARTRV/AGSP; mountain big sagebrush codominant with antelope bitterbrush and a bluebunch wheatgrass understory would be ARTRV-PUTR2/AGSP. Dominance of the tree layer by % composition of the canopy cover and dominance of shrubs, grasses and forbs by air dry weight will be determining criteria for the plant name.

Date: When current description has been written or revised.

<u>Initials</u>: The initials of the author's and their respective agencies responsible for completing the original document or subsequent revision.

#### PART A: DESCRIPTION OF SITE

#### 1. <u>Landscape Factors</u>

#### a. Geographic Location

- (1) MLRA Name: Use only those names listed in Land Resource Regions and Major land Resource Areas of the United States, e.g., CENTRAL NEVADA BASIN AND RANGE. (ref. Agriculture Handbook 296)
- (2) Local Area: List up to three areas which the site has been identified, e.g., OSGOOD MOUNTAINS, DIXIE VALLEY.

  (ref. USGS quads)
- (3) Typical Location: Provide all information as listed. The Universal Transverse Mercator (UTM) grid coordinates are entered where known.

#### b. Physiography

- (1) Landform: These should be identified from the broadest grouping (e.g. HILL, MOUNTAIN) to the more specific, (e.g., CREST, SIDE SLOPE); NSH, Part 607, Glossary of Landform and Geologic Terms is the reference for standard terms to be 'used.
- (2) Elevation/aspect: These entries will identify the lower and upper limits of elevation and any relation of elevation to aspect, e.g., Low 5200 ft/N, NE and High 7100 ft/S, SW.
- (3) Slope: The low-high entries for percent slope is given for the normal areas of occurance that represent the site. The abnormal extremes sometimes encountered should be excluded from the ranges.
- c. <u>Associated Water Features</u>: **Riparian** and wetland (reserved). For the present, any information or data that is pertinent should be added to section 1.d. Narrative for future use.
- d. <u>Narrative</u>: Provide a brief descriptive narrative in common terms and, if needed, describe additional information about the site that distinguishes it from other sites.

#### 2. Climate Factors

a. Soil Moisture Regime: Up to two entries i.e., TORRIC, ARIDIC or XEROLLIC, ARIDIC-XERIC. (e.g. ARIDIC-XERIC is used to indicate an aridic moisture regime that borders a xeric moisture regime). (ref. Soil Taxonomy, pp. 51-57).

- b. <u>Soil Temperature Regime</u>: Up to two entries using the following PERGELIC, CRYIC, FRIGID, MESIC, **THERMIC**, HYPERTHRRMIC, ISOFRIGID, ISOMESIC, ISOTHERMIC OR ISOHYPERTHERMIC. (ref. Soil Taxonomy, pp. 57-63).
- c. and d. <u>Soil Temperatures</u>: Complete all low-high entries as reflected by the soil family(s) grouped into the site.
- e. through g. Mean Annual Temperature, Precipitation and Frost-Free

  Period: Complete all low-high entries based on the nearest weather station data thought to represent the site or your best judgment.
- h. <u>Moisture and Temperature Distribution</u>: Complete all entries based on the nearest weather station data thought to represent the site. If none exists, use your best judgment or leave blank.
- i. <u>Climatic Weather Station</u>: Indicate the source of the data noted in h. above. e.g. <u>Location</u>: BEST JUDGMENT FROM DATA SOURCES NEAR PHOENIX, A2 or PHOENIX **USO** AP, **MARICIPA** COUNTY, ARIZONA; Station number: 026481.
- j. <u>Narrative (Climatic Fluctuations</u>): Refer to item 1.d.; may include drought cycles, flooding cycles, etc.
- 3. <u>Soil Factors</u>: Complete all entries based upon the representative range of soil properties for the soil(s) listed in section 9 to typify the site. The majority of the data entered is taken from **the' SCS** Form 5's. Use the list of soils grouped into the site to determine the dominate soil properties used to represent the site. (ref. NSH, Part 603, Application of Soil Information)
  - a. Major Soil Family(s) and Classification Typical for the Site: i.e.,

Subgroup Family Adjective
LITHIC XEROLLIC HAPLARGIDS CLAYEY-SKELETAL, MONTMORILLONITIC, MESIC

#### Names of families

Each family requires one or more names. The technical family name consists of a series of adjectives modifying the subgroup name. For these adjectives we take the class names that are given later for particle-size class, mineralogy, and so on, in family **differentiae (ch.** 18, Soil Taxonomy). To have consistent nomenclature, the order of adjectives in names of families is particle-size class, mineralogy class and subclass (calcareous), reaction class, temperature, depth, slope, consistence, coatings, and cracks.

An alternate family name is the name of one of the series in the family. This is a shorter name intended primarily for use where a long name is inconvenient. (ref. Soil Taxonomy, p. 88)

#### b. Geologic Formation

- (1) F<u>ormations</u>: Broad geologic formations as identified on state, county or local geology maps, i.e., MANCOS SHALE, DAKOTA SANDSTONE.
- (2) Parent Rock (or material): Use NSH, Part 607, Glossary of Landform and Geologic Terms.

#### c. Features of Soil Surface

(1) "0" horizon: Enter the minimum and maximum range in thickness and the type of horizon e.g., minimum 0.5 (inches), maximum 3 (inches) Type E. Types of "0" horizons are subordinate distinctions within the master soil profile horizon used to identify the degree of organic material decomposition. They include:

A Highly decomposed organic <u>material</u>

E Organic material of intermediate decomposition

I Slightly decomposed organic material

(Adapted From Revised Soil Survey Manual, pp. 4-43, 44)

(2) Rock Fragments: Enter the low-high percent of the soil surface covered by any or all of the **size** fragments listed in Table 1.

"Rock fragments are defined as unattached pieces of rock 2 mm in diameter or larger." (ref. Revised Soil Survey Manual, p. 4-57)

TABLE 1
Terms for Rock Fragments

Shape 1/ and size	Noun	Adjective		
Rounded, subrounded angular, or irregular:				
2-7.6 cm diameter	Grave12/	Gravelly.		
0.2-0.5 cm diameter	Fine gravel	Fine gravelly.		
<b>0.5-2</b> cm diameter	Medium gravel	Medium gravelly.		
2-7.6 cm diameter	Course gravel	Course gravelly.		
7.6-25 cm diameter	Cobble	Cobbly.		
25-60 cm diameter	Stone	stony.		
> 60 cm diameter	Boulder	Bouldery.		
Flat:				
0.2-15 cm long	Chanuer	Channery.		
15-38 cm long	Flagstone	Flaggy.		
38-60 cm long	Stone	Stony.		
>60 cm long	Boulder	Bouldery.		

<sup>1/</sup> If significant to classification or interpretation, the shape of the fragments is indicated: "angular gravel," "irregular boulders."

(ref. Revised Soil Survey Manual, pp 4-97)

 $<sup>\</sup>underline{2}$ / A single fragment is called a "pebble."

#### d. Surface Texture:

Definition: USDA texture refers to the U.S. Department of Agriculture's soil texture classification as defined in the Soil Survey Manual. Soil texture is the relative proportion by weight, of the several soil particle size classes finer than 2 mm in equivalent diameter. The material finer than 2 mm is called the fine earth fraction. Material larger than 2 mm is called rock fragments. (ref. NSH, p. 603-4)

As many as four textures can **be** entered on each line. Separate them by commas. If texture modifiers are used, they must be attached to the texture by a hyphen; e.g., GR-SL. Use only terms from the Table 2. (ref. NSH, p. 603-197)

#### e. Surface Horizon:

- (1) Diagnostic Surface Horizon: Enter one of the following MOLLIC, ANTHROPIC, UMBRIC, HISTIC, PLAGGEN OR OCHRIC. (ref. Soil Taxonomy, pp. 14-19)
- (2) Thickness: Enter the minimum and maximum range in thickness of the above named diagnostic surface horizon for the soils that are most representative of the site.

#### TABLE 2

#### USDA Texture

## <u>Texture Modifier:</u>

### Texture terms:

# Terms used in-lieu of texture:

BY Bouldery BYV Very bouldery BYX Extremely bouldery CB Cobbly CBA Angular cobbly CBV Very cobbly CBX Extremely cobbly CN Channery CNV Very channery CNX Extremely channery CR Cherty CRC Coarse cherty CRV Very cherty CRX Extremely cherty FL Flaggy FLX Extremely flaggy FLX Extremely flaggy GR Gravelly GRC Coarse gravelly GRF Fine gravelly GRV Very gravelly GRX Extremely gravelly MK Mucky PT Peaty RB Rubbly SH Shaly SHV Very shaly SHX Extremely shaly SR Stratified ST Stony STV Very stony STX Extremely stony STX Extremely stony SY Slaty	COS S FS VFS LCOS LS LFS LVFS  COSL SL FSL VFSL  L SIL SCL CL SICL CC SICC C	loam Loam Silt loam Silt Sandy clay loam Clay loam	CE C M CIND DE FB FRAG G GYP HM ICE IND MARL MPT MUCK PEAT SC SP UWB VAR WB	Coproge Cemente Cinders Diotoma Fibric Fragmen Gravel Gypsife Hemic Ice or Indurat Marl Mucky-Muck Peat Sand an Sapric Unweath Variabl Weather
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CE Coprogenous earth
C M Cemented
CIND Cinders
DE Diotomaceous earth
FB Fibric material
FRAG Fragmental material
G Gravel
GYP Gypsiferous material
HM Hemic material
ICE Ice or frozen soil
IND Indurated
MARL Marl
MPT Mucky-peat
MUCK Muck
PEAT Peat
SC Sand and gravel
SP Sapric material
UNB Unweathered bedrock
VAR Variable
WB Weathered bedrock

SW Very Slaty
SYX Extremely slaty

f. <u>Soil Depth</u>: Enter the minimum and maximum depth in inches for the most representative soils for the site to correspond with the class limits listed below. Make sure not to exceed more than 2 depth classes, e.g., MODERATELY DEEP OR DEEP.

Depth to a restricting or contrasting layer is measured from the soil surface. For soil with an 0 horizon that has never been saturated for prolonged periods, the soil surface is the top of the part of the 0 horizon that has decomposed so much that most of the original material cannot be recognized with the naked eye. If the uppermost horizon is an 0 horizon that is or has been saturated for prolonged periods, the soil surface is the top of that horizon. Otherwise, the soil surface is the top of the mineral soil.

So that the terms used to indicate depth will have approximately the same meaning everywhere, the following classes are suggested:

Very shallow	Less than 10 inches
Shallow	10 to 20 inches
Moderately deep (moderately shallow)	20 to 40 inches
Deep	40 to 60 inches
Very deep	More than 60 inches

(Adapted From Revised Soil Survey Manual, p. 4-27)

**g.** Major Root Zone Thickness: Enter the minimum and maximum range of thickness where <u>common</u> and <u>many</u> roots occur in the most representative soil profiles for the site.

Quantity classes of roots are defined in terms of numbers of each size per unit area-1 square centimeter for very fine and fine roots and 1 square decimeter for medium and coarse roots. All roots smaller than 10 mm in diameter are described in terms of the following quantity classes.

Few: Less than 1 per unit area of the specified size Common: 1 to 5 per unit area of the specified size Many: More than 5 per unit area of the specified size

(ref. Revised Soil Survey Manual, p. 4-86)

h. AWC for Effective Plant Root Zone: This is the **zone** dominated by common and many roots reflected in the data previously presented in item 3.g. above.

Available water capacity (AWC) is defined as the capacity of a soil to hold water in a form available to plants, usually expressed in inches of water per inch of soil depth. Commonly defined as the amount of water held between field capacity and wilting point. (ref. NSH, p. 603-20)

Enter the estimated range of available water capacity in inches per inch, e.g., 0.10-0.15. If zero, enter "0". (ref. NSH, p. 603-199).

i. Accumulation: many soils have increases in physical or chemical properties which may influence a plant community. Enter in this section the minimum and maximum soil depth in inches where an accumulation starts, the type of accumulation, low-high amount of the accumulation below the depth listed and one of the following type of measurement (%, ppm or meq /100 gm). Kinds of accumulation are to include but not limited to organic carbon, clay, calcium carbonate equivelent, gypsum, durinodes, etc. These should be listed even though the accumulation is a small amount but may ultimately be important in the site interpretations.

Example of entries are:

Dept Minimum (Inches)	h To Maximum (Inch	<u>e</u> s) <u><b>Type</b></u>	Amount Low <b>High</b>	Measurement (%, PPM, meq/100gm)
12	to <u>14</u>	CLAY	_ 35 to 40 _	<b>X</b>

- **j.** 35 to 50% (vol) rock fragments: enter both the minimum and maximum depth to where the soil contains >35% by volume rock fragments and the average thickness of the layers where rock fragments range from 35 to 50% by volume.
- k. >50% (vo1) rock fragments: same as for the 35 to 50% above except identify depth and average thickness of the layers where >50% rock fragments occur.
- 1. <u>Reaction</u>: The degree of acidity or alkalinity of a soil, expressed as a pH value.

 $\underline{\underline{Classes}}$ . Descriptive terms commonly associated with ranges in

Ultra acid	c 3 . 5
Extremely acid	3.5 - 4.4
Very strongly acid	4.5 - 5.0
Strongly acid	5.1 - 5.5
Moderately acid	5.6 - 6.0
Slightly acid	6.1 - 6.5
Neutral	6.6 - 7.3
Mildly alkaline	7.4 - 7.8
Moderately alkaline	7.9 <b>-</b> a.4
Strongly Alkaline	8.5 - 9.0
Very strongly alkaline	79.0

(ref. NSH, pp. 603 - 24,25)

Enter the range of pH(1:1 water, except Histosols which are measured in 0.01M CaCl<sub>2</sub>). Use the following classes: <3.6,3.6-4.4,4.5-5.0,5.1-5.5,5.6-6.0,6.1-6.5,6.6-7.3,7.4-7.8,7.9-8.4,8.5-9.0,79.0, or a combination of classes, e.g., 4.5-5.5. (ref. NSH, p. 603-199)

m. <u>Salinity</u>: Salinity is the concentration of dissolved salts in water. It is used to indicate the existence of saline soils.

Classes.	Electrical Conductivity Mmhos/cm (dS/m)
Nonsaline	< 2
Very slightly saline	2-4
Slightly saline	4-8
Moderately saline	8-16
Saline	> 16

(ref. NSH, pp. 603-26)

Give a range of the electrical conductivity of the saturation extract during the growing season. Use the following classes: < 2, 2-4. 4-8, 8-16, > 16, or combination of classes, e.g., 2-8, >8. If salinity is no problem for growing plants, enter a dash. (ref. NSH, pp 603-199)

n. <u>Sodicity:</u> The sodium absorption ratio **(SAR)** is the standard measure of the sodicity of a soil. The sodium absorption ratio is calculated from the concentrations (in **milliequivalents** per liter) of sodium, calcium, and magnesium in the saturation extract.

(ref. Revised Soil Survey Manual, p. 4-92).

Give a range of the SAR in the saturation extract during the growing season, e.g. 15-25. If sodicity is no problem for growing plants, enter a dash.

o. Annual Pattern of Soil-Water States: The annual pattern of soil-water states provides a continuous record of the moisture conditions of the soil. These entries are estimates of how dry, moist **or** wet the **soil** may be during each month of the year by soil depth. An annual pattern for a hypothetical soil is shown below:

Example:

J 	F 	M I	l A i	M	J	J	A	S	10	N	і в і І І
\ F	P	м	H	H	м	D	D	Đ	M	М	P
ļ ļ F	]   F	l P	   ₩	м	M .	М	ם	Ð	Ð	   M	[ w ]
W	   ឆ	l Wi	l Wi	M	м	М	Ð	Ð	D	H	м
W	!  ₩	ן Į₩ ∣	   W	W	M	M	M	ם	ס	D	   H
W	₩ -	  ₩.	i W	   W	   W	М	м	м	ם [	D i	M
	   F   W   W					F	F				

F: frozen more than half of the month

W: wet more than half of the month

M: moist more than half of the month

D: dry more than **half** of the month

### p. Water table:

- (1) <u>Depth To</u>: enter the minimum and maximum expected depth range of a seasonal high water table or zone of saturation for representative soils during the <u>growing season</u> to the nearest half foot, e.g., 0.5-1.5, 2-3, etc. If the water table is below 5 feet, leave blank.
- (2) Rind: The three kinds of water tables are apparent, perched or artesian. Enter apparent unless it is known that the water table is perched or artesian.
- (3) Months: enter the month(s) when a water table is expected to occur during the growing season at less than 5 feet as above. Use the first three letters of the month as abbreviations, e.g., MAY-JUN. (ref. NSH, p. 603-200).
- q. Narrative: Refer to item 1.d.
- 4. <u>Vegetation Factors</u>: all vegetation factors are to express the situations as they occur or will occur in the potential natural (PNC) or climax plant community. (ref. NRH, 302.3)

#### a. Cover:

#### (1) Foliar Projection Ground Cover and structure:

- (a) <u>Percent Cover</u> is the percentage of ground covered from a projection of the foliar canopy from the vertical view in order of the dominant life form. Do not include the amount overlapped by a taller life form; the sum should equal the total plant cover as observed from the vertical view.
- **(b)** Average Height for each life form should be listed in feet and tenths of feet as an indication **of** vertical structure.
- (2) <u>Basal Cover</u>: is that percentage of the ground surface actually occupied by vascular vegetation.
- (3) <u>Litter/Residue</u>: Litter (mulch) is a non-living plant material detached from the plant and on the soil surface (SRM, 1974). Residue may also include standing dead material.
  - (a) Rind enter  $\underline{N}$  (non-persistent),  $\underline{P}$  (persistent) and/or R (residue).

Non-persistent litter is primarily herbaceous material with an expected decomposition rate of two years or less. (BLM, 1985)

Persistent litter is composed of woody material and large mammal droppings with an expected decomposition rate exceeding two years. (BIM, 1985)

Residue (residual dry matter) is the standing dead and litter of herbaceous plants. (USFS, 1984)

- (b) % Cover enter the Low-High range of % ground area covered from the vertical view.
- (c) <u>lbs/acre (ADW)</u> enter the Low-High range of Air Dry Weight (ADW) of the litter/residue in pounds per acre.
- b. <u>Vascular Plant Community Composition and Production</u>: Vascular plants are grouped from the tallest life form to the smallest (also refer to habit as listed in the National List of Scientific Plant Names, **SCS**).
  - (1) O<u>verstory Trees</u> Symbol, Site Index, and % Canopy Cover are required. Common name, Basal Area, Ft<sup>3</sup>/acre/yr, average density and percent composition canopy are optional.
  - (2) Understory Symbol and Composition Air Dry Weight (ADW) are required other entries are optional.
  - (3) Total Annual Production Total average annual production from all plants growing on the site should be recorded in pounds per acre for favorable years, average years, and unfavorable years.

#### Column Heading Entries:

<u>Symbol</u> - Enter appropriate plant symbol from the National List of Scientific plant names (NLSPN) as amended.

<u>Common Name</u> - The use of common names is optional and may be from the NLSPN or according to a states preference.

Basal Area - Enter for trees only. It is the cross sectional area usually measured at breast height except for pinyon-juniper communities where measurement is usually 6 to 12 inches high.

<u>Site Index</u> - Enter trees only and should be from the accepted reference for natural variability within the site.

- <u>Ft<sup>3</sup>/acre/yr</u> Enter the wood volume in cubic feet per acre at the culmination of mea\* annual increment. A range is allowed.
- % Canopy Cover Enter the percentage of ground covered by a vertical projection of the outermost perimeter of a plants foliage. The sum of canopy covers for individual species may exceed 100%. A range is allowed.
- Composition Canopy Enter the percentage of each species in the canopy as observed from the vertical view. A range is allowed.

Average Density - Enter the number of individuals or stems per acre.

<u>Site Index References</u> - List tree symbol, author and date of publication for each site index used.

Group - Enter a group number, beginning with the number one and use this number only one time per range site. This is a method of grouping or bracketing species. Often it is beneficial and in some cases necessary to bracket the percent composition of a single species that occurs in combination with several other species on a given range site. The percent composition ratio that occurs between the individual species in the group may change from location to location within the site, but the total composition for the group of species remains constant. For this reason, species that fit into a "group category" may be grouped together. All species designated to a group will be assigned identical group numbers.

Composition Air Dry Weight (ADW) - Enter the percentage of the annual air dry production that would normally be expected for a species when the community is in PNC or Climax. A range is allowed. The sum of the high range should never exceed 140% and normally would be 120% or less for stable perennial plant communities.

Other - Enter incidental plant species that in aggragate can comprise a significant composition but by themselves are not to exceed (NTE) a small amount. e.g. 2 PERCENT.

- c. <u>Cryptogamic Community Production and Composition</u>: This section is for tundra and similar ecosystems. Live lichen and moss production cannot be measured accurately on an annual growth basis, therefore, the cryptogamic component is handled separately. Entries are composition of the total production and <u>not</u> composition of the annual production.
  - (1) Lichen Biomass Symbol and percent composition ADW is required. Common name and percent canopy cover is optional.
  - (2) Moss/Clubmoss Biomass Symbol and percent composition ADW is required. Common name and percent canopy cover is optional.
  - (3) Crytogamic Community Production Production is total live biomass in pounds per acre ADW. Enter the total low, high and average pounds per acre for lichen and moss/clubmoss biomass.
- d. <u>Documentation</u>: Summarize the amount of hard data available that the vegetation portion of the site descriptions was based upon. Transects are considered to be measured data recorded on SCS Range 417 forms and equivalent agency forms, approved forest mensuration forms and other actual measurements. Data sheets are considered to be any **occular** estimates of production, composition, etc., recorded and retained for documentary purposes.
- e. Narrative: Refer to item 1.d.

#### 5. Wildlife

a '1

- (a) species List: List only those animals that are associated with or are expected to use the site in the potential or climax situation. The list of animal species associated with the site should only reflect those species thought to directly influence the plant community dynamics. Animals may or may not use a site all or part of its life cycle due to its setting or association with other sites.
- (b) Narrative: Refer to item 1.d.
- 6. <u>Community Dynamics</u>: Briefly describe known or expected time relationships attributed to natural disturbances such as periods between wildfire, cyclic insect infestations, etc.
- 7. Commonly Associated Sites: List under the appropriate upland or riparian-wetland heading, the number and name of the sites that generally occur in complex, association or adjacent to the site being described and any additional descriptive text needed.
- 8. <u>Competing Sites</u>: List the number and name of those sites that may be confused with the site being described. (Optional Enter additional differentia or other descriptive text if desired.)
- 9. <u>Soils Grouped Into the Site</u>: List the soils grouped into the site by soil survey area number, map unit symbol, soil component name and phase. i.e.,

Survey Area	Map <b>Unit</b>	Soil Name and Phase
775 767 767	1034 1503 908	*SONOMA SILT LOAM, FREQUENTLY FLOODED SONOMA FAMILY LOAM, STRONGLY SALINE-SODIC ARIDIC ARGIXEROLLS, 15 TO 30% SLOPES

<sup>\*</sup>Indicates the soil **taxon** is one that doesn't have supporting vegetation documentation.

# STANDABD SITE DESCRIPTION

		1	lumber	
		S	Site Name _	
		1	Plant Name	
		I	Date	
			Initials:	Author's/Agency
PAR'	r A:	DESCRIPTION OF SITE		
1.	Land	dscape Factors		
	a.	Geographic Location:		
		(1) MLRA Name: (2) Local Area:	9	,
		(3) Typical Location: Legal: 1/4; 1/4; 1/4 Latitude: Deg. Min. Longitude: Deg. Min. UTM Coordinate:	Sec.	T RMeridian
	b.	Physiography:		
		(1) Landform:     (a) Broad     (b) Specific (2) Elevation/Aspect:     Low/ (3) Slope: Low:/	,	/
	c. A	Associated Water Features: Ripa	rian and We	etland (Reserved).
	d.	Narrative:		
2.	Clim	mate Factors		
	a. b. c. d. e. f.	Soil Moisture Regime: Soil Temperature Regime: Mean Annual Soil Temperature: Mean Summer Soil Temperature: Mean Annual Air Temperature: Mean Annual Precipitation: Frost-Free Period:  to	toto	

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Moisture and Temperature Distribution:

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
PPT	HIGH													(inches)j	ET q 1	7
							_			,						
						=										
										_						
			-													

h.	AWC for Effective Plant Root Zone: Low High (inches/inch)
i.	Accumulation (clay, Caco3, etc.):
	Depth Minimum Maximum Amount Measurement (Inches) (Inches) Type Low High (%, PPM, meq/100gm)
	to
j.	35% to 50% (vol) Rock Fragments: (1) Depth: Minimum (inches) Maximum (inches) (2) Average Thickness: (inches)
k.	50% (vol) Rock Fragments: (1) Depth: Minimum (inches) Maximum (inches) (2) Average Thickness: (inches)
1.	Reaction: pH
	Surface Layer: LOW HIGH Particle-Size Control Section: LOW HIGH
m.	Salinity: mmhos/cm
	Surface Layer: LOW HIGH Particle-Size Control Section: LOW HIGH
n.	Sodicity: SAR
	Surface Layer: LOW HIGH Particle-Size Control Section: LOW HIGH
Ο.	Annual Pattern of Soil-Water States:
	Depth JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC 0-4" 4-10" 10-20" 20-40" 40-60"
p.	Water Table (During Growing Season): (1) Depth: Minimum (Ft) Maximum (Ft) (2) Kind: (3) Month(s): to
<b>q</b> .	Narrative:

а.	Cove	r:							
<b></b> F		Foliar Projection Groun			ucture:				
				Cover cal View	,)	λτ	n Height	(f+)	
		Trees	( VELCIC	Jai view	<u>-</u> / -	AV	neight	. (16)	
		Shrubs Grasses, Grass Like,			_			•	
		& Forbs			_				
		Cryptogams			_				
	(2)	Basal Cover:%	total						
	(3)	Litter/Residue:							
		Kind1/	% Cover	. ,	1bs./Acre	(ADW)			
			<del></del>						
		1/N = non-persistent P = persistent R = residue							
b.	Vasc	P = persistent	omposition	n and Pr	roduction:				
b.		P = persistent R = residue	omposition	n and Pr	roduction:				
b.		P = persistent R = residue cular Plant Community Co			roduction:				
b.		<pre>P = persistent R = residue  cular Plant Community Co Overstory Trees:</pre>				<b>9</b>	2		
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	<b>%</b> Canopy	<b>%</b> Compos	ition	Den
b. Symbol	(1)	<pre>P = persistent R = residue  cular Plant Community Co Overstory Trees:</pre>		£	it <sup>2</sup>	Canopy	· -	ition	Den
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Den
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Den
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Den
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Den
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Den
	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Den
Symbol	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)  Common Name		£	it <sup>2</sup>	Canopy	Compos	ition	Den
Symbol	(1)	P = persistent R = residue  cular Plant Community Co  Overstory Trees:  Basal Area (all trees)		£	it <sup>2</sup>	Canopy	Compos	ition	Dens

	(2) Understory: (a) Shrubs (and underst	ory trees, if a	pplicable)-	Tot	al
<u>Symbol</u>	<u>Common Name</u>	Group	% Canopy Cover	% Composition Air Dry Wt	
		- —			
		_		<del></del>	
Other -		w		NTE	e
		_			
		<u>-</u>			
		_			
		_			
					_
	(b) Grasses and <b>G</b>	rass Like	na (17) ann mha dh' ann a'nn ant-ma dan an an m		tal
Symbol_	Common Name	Group	<b>%</b> Canopy <u>Cover</u>	% Composition Air Dry Wt	
			-		
				<del></del>	
				مناسبات کانبینسیات	
Other	د شره بچند لوب چیش ویب شای بوب بری البه ویب آلوب جانا ویب آلگ های باید انگا جند الوب سال است باگل بنگا 300			NTE	es
		_			
	•	_			
		_			
		_			

	(c) Forbs			Total	
Symbol	Common Name	Group	<b>%</b> canopy Cover	% Composition Air Dry Wt	
			<del></del>		
		<del></del>	<del></del>	30.14.624	Tc 0
			*******		
	_		_		
		<del></del>			

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Other -	(1) Lichen Biomass (0			NTE	es
	Common Name				
	(2) Moss/Clubmoss Bi	omass (100%)	<b>%</b> Composition		
Symbol_	Common Name	% Canopy cover			
				_	
				_	
				_	
				_	
				NTE_	ea
	(3) <b>Crytogamic</b> Commun (a) Total Licher <b>Range:</b> Low	n Biomass:  High	lbs/acre		
	Average: _	1bs/acre			
		lubmoss Biomass: High 1bs/acre	lbs/acre		

1 4

	<pre>d. Documentation: Seral Stage (Condition)</pre>	#Transects	# Data Sheets
	Potential (Climax) Late (Good)		
	Mid (Fair) Early (Poor)		
	e. Narrative:		
5.	Wildlife		
J.	a. Species List:		
	b. Narrative:		_
6.	Community Dynamics (Fire, etc.	.):	
7.	List of Commonly Associated S: a. Upland:	ites (number and nam	me):
	b.		
8.			
9.			
	Soil <b>Map</b> Survey <b>Unit</b> Area <b>Symbol</b>		
	*******		

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### SOIL TAXONOMY COMMITTEE PEPORT

With the transition of Soil Taxonomy role from NTC to Center to NTC, there has been less than favorable action of this committee. My role of Chairman will change to a coordinator role to disperse and assemble comments from the committee members.

There is lots of activity in Soil Taxonomy and with completion of the Soil Classification staff at Lincoln, even more changes will follow.

The International committee are active and many changes can be anticipated from these committees.

The Andisol proposals are approved and will appear in 1989 in the keys.

Many Aridisol proposals were discussed at the Aridisol tour last year thru Texas, New Mexico, Arizona, and California. A cold Aridisol tour is in the planning for August 1989 thru Canada, Montana, Wyoming, Idaho and Utah.

The format for Soil Taxonomy subgroup change to a key was discussed and agreed upon. Comments to priorities will be sent to John Witty by members.

Please send proposals to WMTC for processing.

Committee members are with their expiration date:

1988 Alan Busacca and Thor Thorson

1989 Wayne Robbie and Gordon Huntington

1990 Joe Moore and Phil Derr

Nominated are: Bob Engel, SCS, Washington; Chester Novac, BIM, Salem, Oregon; Hayes Dye, SCS, Colorado: Randy Southard, University of California.

Elected were: Bob Engel

Randy Southard

# Interpretations Committee - 1988

#### Committee Members-

1990 - Gordon Decker, SCS, MT

1990 - Earl Alexander, FS, AK

1988 - Jim McLouglin, RLM, NV

1988 - Bob Meurisse, FS, OR, Chair

1987 - John Rogers, SCS, CA

1987 - Jan Cipra, CO State Univ.

- Herb Huddelston, OR State Univ.

# Committee Charges:

- (1) Review and comment on new soil interpretation criteria.
- (2) Encourage development of new interpretations as needed.
- (3) Encourage or promote the testing of existing criteria.

#### Activities:

- 1. The committee has reviewed a revised erosion hazard rating system developed by the California Soil Survey Committee for use on Forest, Range, and croplands. Agencies in Califoria and the Forest Service in the Pacific Northwest Region are testing it. It appears to have improvements over the current EHR for sheet and rill erosion to give a better stratification of erosion hazard.
- 2. The Northern Region of the Forest Service reports a number of interpretations for mapping units. The committee reviewed these.

In addition to some standard ratings normally given to texonomic units, such as site index, mean annual growth in cubic volume, basal area and common trees; limitations for tractor operation, regeneration, erosion hazard and habitat types are reported.

Ratings for tractor operation include: wet areas, steep slopes, complex slopes and soil damage. Regeneration ratings include: wet soils, moist openings, frost pockets, competition, mositure stress, solar insolation and harsh climate.

The criteria are very general and not always specified. For example, "moisture stress is associated with open dry and dry mixed coniferous forest and southerly aspects with grand fir/beargrass community types in other vegetative groups." No specific soil or landscape properties, qualities or features are given.

Question - How do we distinguish clearly between taxononic interpretations and mapping unit interpretations?

#### Recommendations:

- 1. Clearly distinguish between toxonomic and mapping unit based interpretations. Documents should specify the difference.
- 2. New interpretations in NCSS publications or data bases should be reviewed prior to their publication.

### Tasks for short term:

- 1. Give special emphasis to working with the soil/range team to review and test new interpretations.
- 2. Encourage further testing and use of the erosion hazard rating criteria. (Copy enclosed with report).
- 3. Review criteria for soil resilience for compaction, erosion and fertility for Forest and Range lands. Note: Resilience is defined as the ability to rebound, recover, and resist significant long-term degradation. Tentative criteria are enclosed.
- 4. Establish a format or process for reviewing and testing new interpretations.

# Committee members for next term:

- 1991 Gerald Simonson, Oregon State University, Corvallis, OR.
- 1991 Dave Smith, California Department of Forestry, Redding, CA.
- 1990 Gordon Decker, SCS, Bozeman, MT.
- 1990 Earl Alexander, USFS, Juneau, AK.
- 1989 Jim McLoughlin, BLM, Reno, NV. 1989 Bob Meurisse, USFS, Portland, OR.

Compaction resilience	High M	egree <b>of</b> Resilience oderate	Low	Factors limiting resilience
Organic carbon content (\$) of surface 6 inches.	>8	2-7	<2	Surface content organic
Organic carbon content (\$) in 6-12 inch depth.	2-8	1-2	<1	Low organic matter below surface.
Litter thickness (inches) (0 horizon)	<b>&gt;3</b>	1-2	<1	Thin litter layer.
Soil structure of family control section.	Strong coarse, medium	Moderate, medium, coarse single grain.	<b>Weak,</b> fine, very fin	<b>Weak</b> soil structure. ie.
Depth to permeability <moderate (inches).<="" td=""><td>&gt;40</td><td>20-40</td><td>&lt;20</td><td>Poor aeration.</td></moderate>	>40	20-40	<20	Poor aeration.
Depth of frost (inches).	>12	6-11	<6	Laok of frost action
Texture of family control, section.	co sl and coarser	fsl, sil, 1	cl, sicl sol, c, sc, sic	Poor tilth.
Shrink-swell potential of family control section.	High-clay,si Low-sil, fsl and coarser		Low	Low shrink -swell
Plasticity index	NP-5	5-15 <b>&gt;50</b>	15-50	Intermediate plasticity.

# Erosion Resilience

Factors affecting resilience	High	<u>Degree of resilience</u> Moderate	Lcw	Factors limiting resilience
Organic carbon content(%) of surface 6 inches	>8	2-7	<2	Low surface organic matter.
Infiltration capacity soil.	Rapid	Moderate	Slow	Slow infiltration rates.
Permeability of subsoil.	Rapid, v.rapid	Mod. <b>-mod.</b> rapid	Mod- slow, v.slow.	Slow permeability rates.
Depth of solum or root restricting layer. (inches)	>40	20-40	<20	Shallow soil depth.
Surface soil structure.	Strong granular blocky	Moderate granular r blocky, platy.	Weak or struc-tureless	Weak soil structure
K factor-surface	<.15	.1643	>.44	High inherent erodibility of surface soil.
K factor-subsoil	<.15	.1648	>.49	High inherent credibility of subsoil.
Slope (%)	<30	30-60	>60	Steep slopes.
Soil moisture regime	Udic	Xeric-Udic	Xeric	
Soil temperature regime	Mesic Isomesic	Frigid e	Cryic	Cold soils.

# <u>Fertilityresilience</u>

Factors affecting resilience	High	<u>Degree of resilience</u> Moderate	c <u>e</u> Low	Factors limiting resilience
Organic carbon content (%) in surface 6 inches.	>8	2-7	<b>&lt;</b> 2	Low surface organic matter.
Organic carbon content (\$\forall 1) in 6-12 inch depth.	2-a	1-2	<b>&lt;</b> 1	Low below surface organ10 matter.
Depth to root restricting layer (inches).	>40	20-40	<20	Shallow rooting zone.
Plant avail. water holding capacity (inches).	>10	6-10	<6	Low water supply.
Texture of family control section.	l,cl, sil, sicl	all others	co sl & coaser	Low in exchange capacity
Soil acidity of family control section (pH).	5.6-7.8	5.0-5.5 <b>7.9-8.4</b>	<5.0 >8.5	<b>Very</b> strongly acid or strongly alkaline.

# DRAFT

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		Rating	<u> </u>							
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		7 10 9 • 3			18 - 6					
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2205	10	N NAZARD RATING	LOW		MODERATE		H 1 GH	AEBA	11 ) 61)	

# California Soil Survey Committee' Interagency EHR Tosk Group October 1987

# EROSIONHAZARD RATING FACTORS for SHEET AND RILLEROSION

#### **OUTLINE**

I. SOIL ERODIBILITY - Factor range is 1 to 4

Soil texture and slope group combinations are used to compensate for particle size class erodibility differences due to slope gradient)

- II. RUNOFF POTENTIAL (Equals Production X Energy) Factor range is 0 to 5
  - A. Runoff Production (Major factors that influence surface flow)
    - 1. Climate (2 year -6 hour precipitation intensity)
    - 2. Water □ ovencnt in the soil
      - a. Infiltration (water movement through surface soil)
      - b. Permeability (water movement through subsurface soil)
      - c. Depth to a layer that restricts water movement (<20", 20-40", >40")
    - 3. Runoff from adjacent and/or intermingled areas (Rock outcrop or other impervious or nearly impervious surfaces)
    - I. Slope Shape and Uniform Length

Slope shape (Concave-water accumulates, Convex-water disperses)

Uniform slope distance (Slope length and surface variation)

Runoff production factors are added together to form rating.

B. Runoff Energy

Slope gradient (Percent)

III. SOIL COVER

## California Soil Survey Committee Interagency EHR Task Group October 1987

# EROSION HAZARD RATING (EIR) COMPUTATION FOR SHEET AND RILL EROSION

### INSTRUCTIONS

### I. SOIL ERODIBILITY

Soil textural classes and slope are used to represent relative soil erodibility. Slope is used to compensate for particle size class erodibility differences due to slope gradient. Relative erodibility factors are based on calculations using USLE textural K-values. particle size transport values. and slope correction factors.

Table 1:	Relative	Soil	_Erodibility_	Factors

Textura	l Class	0-15%	Slope 16-30%	Steepness 31-45%	46-60*+
Sandy	sand	1	4	<b>2</b> 3	3 3 3
<b>Sandly</b>	cl hyamlon	m 22	2	<b>3</b> 3	3
Sanďý	člay	1	1	1	1
Clay		1	1	1	1
Clay	loam	2	2	2	2
Loam		3	3	3	3
Silty	clay	2	$\overline{2}$	$\overline{2}$	$\overline{2}$
	lay loam	3	3	3	3
Silt	loam	Ĺj.	4	Ĭ4	Ĭ4
Silt		4	4	4	4

Soil Erodibility Factor Ratings:

1 = Low 2 = Moderate 3 = High 4 = Very high

## II. RUNOFF POTENTIAL

### A. **Runoff** Production

1. Climate. The 2-year, 6-hour precipitation map (figure 1) is used as a guide to the relative occurence of significant storm events. Values are used directly from the map to form the rating. More specific information for local areas say be used if available.

DRAFT

- 2. Water movement in the soil. Infiltration, permeability, and the depth to-permeability reduction are inter-related factors that govern the rate of water movement into and through the soil. The result of some combinations of these factors is surface runoff. They are evaluated together, rather than as individual factors in order to avoid off-setting affects.
  - a. <u>Infiltration or the surface soil</u>. Infiltration is the rata or water movement into the soil. Existing or post activity soil conditions are evaluated to determine the likelihood of producing surface runoff. This occurs when precipitation rates exceed infiltration rates. Use the following soil texture. porosity and consistence desciptions as a guide to rating undisturbed conditiona.
    - Rapid. Sands, loamy sands, sandy loams, and fine sandy loams; generally very porous. (>2 inches/hour).

Moderate. Loams ailt loams and friable clay loams; also includes, the more porous soils of finer textures, and the less porous soils of

Sands, loamy sands, sandy loams, and fine sandy loams: generally very porous.

(>2 inches/hour).

Nonsoil Material ilighly fractured, Or loose material, Water movement is not impeded.

Moderate Loams, silt loams, and

friable clay loams; also includes, the more porous soils of finer textures. and the less porous soils of coarser textures. (0.6 to 2.0 inches/hour).

Fractured or weathered material: can be dug with a shovel.

Clay loams and clays that are firm. sticky & plastic:

generally with very few pores. (<0.6 inches/hour).

Very few widely **spaced** fractures. Unweathered or weathered material6

are dense.

c. Depth to layer that restricts water movement. The depth from the soil surface to any layer which slows the downward movement of water. This includes, subsoil layers, cemented layers, clay layers, compacted layers. and weathered or unweathered rock. rockcemented layers, clay layers, and compacted layers. The depth refers to the layer that is rated for subsoil/substrata permeability. Shallow soils over highly fractured bedrock that is permeable to water are not considered to be shallow for these purposes.

Soil depth and the nature of subsurface materials can be observed in road cuts and small soil pits.

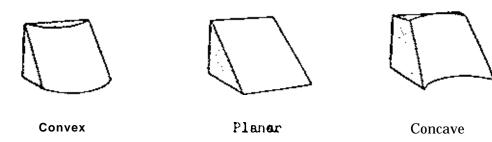
Runoff from adjacent and/or intermingled areas. The amount of and proximity to impervious or nearly impervious surfaces Can increase the production of surface runoff. Impervious or nearly impervious surfaces include rock outcrop. soil areas with water movement (II. 2.) factors totaling 5 or more, and disturbed areas (e.g., compacted areas, roads, and developed areas). This allows for rating complex soil patterns and miscellaneous areas. Use the following as a guide to the ratings.

Low. Less than 15 percent of adjacent and/or intermingled areas contain impervious Or nearly impervious surfaces.

<u>Moderate</u>. Between 15 and 50 pat-cent of adjacent and/or intermingled areas contain impervious Or nearly impervious surfaces.

High. Mom than 50 percent of adjacent and/or intermingled areas contain impervious or nearly impervious surfaces.

- 4. Slope shape and uniform length. The slope shape and length of uniform slope distance are evaluated together to rate the likelihood of dispersion or concentration of runoff water.
  - a. Slope shape. The shape of elope is used to evaluate if surface runoff will be concentrated or dispersed. Select the slope shape from the closest example below.



b. Uniform slope length. Slope length and surface variation are used to reflect the magnitude of slope shape effects on • urTwz\*runoff. The surface microrelief is evaluated by the distance that occur-s before a significant change in water movement may take place. For example, the distance between benches, mounds, flats and other slope breaks is used.

## B. Runoff energy

Slope gradient is used to represent the relative energy of surface runoff. Use the percent slope as measured.

### III. SOIL COVER

A. Quantity and quality.

Ground cover. such as rock fragments (larger than 1/2 inch). low growing vegetation (grasses. forbs, and prostrate shrubs), plant litter and debris is more effective than shrub or tree cover for resisting the effects of raindrop impact and surface runoff. Table 2 compensates for these differences. Ground cover is based on the amount of surface area it covers. Shrub and tree cover is based on the amount of area covered by their canopies. Select the rating number that coincides with the appropriate amounts of ground cover versus shrub and/or tree cover.

Table 2: Soil Cover Factors.

# OROUND COVER

•	Percent	0 - 10	<b>10 -</b> 30	30 - 50	50 - 70	70 - '100
SHRUB AND/	50 - 100 70	3	3	212 3	11	00
OR TREE CANOPY	30 - 50 10 - 30 <10	4 4 5	3 4 4	3 3	21 2	0 0 <b>O</b>

# B. Cover distribution

Variations in the continuity of soil cover is compensated 'for 'with this

# Compaction resilience

Factors affecting resilience		gree of resilience oderate	Low	Factors limiting resilience
Organic carbon content (%) of surface 6 inches.	>8	2-7	<b>&lt;</b> 2	Surface content organic
Organic carbon content (\$) in 6-12 inch depth.	2-8	1-2	<1	Low organic matter below surface.
Litter thickness (inches) (0 horizon)	. <b>&gt;</b> 3	1-2	<1	Thin litter layer.
Soil structure of family control section.	Strong coarse, medium	Moderate, medium, <b>coarse</b> single grain.	Weak, fine, very fin	Weak soil structure. e.
Depth to permeability <moderate (inches).<="" td=""><td>&gt;40</td><td>20-40</td><td>&lt;20</td><td>Poor aeration.</td></moderate>	>40	20-40	<20	Poor aeration.
Depth of frost (inches).	>12	6-11	<6	Lack of frost action
Texture of family control, section.	co sl and coarser	fsl, sil, l	cl, sicl scl, c, so, sic	Poor tilth.
Shrink-swell potential of family control section.	High-clay,sic Low-sil, fsl and coarser	3 Moderate	Low	Low shrink -swell
Plasticity index	NP-5	5-15 >50	15-50	Intermediate plasticity.

# Fertility resilience

Factors affecting resilience	High	<u>Degree of resilience</u> Moderate	ce Low	Factors limiting resilience
Organic carbon content (1) in surface 6 inches.	>8	2-7		
Organic carbon content (%) in 6-12 inch depth.	2-8	1-2	<1	
Depth to root restricting layer (inches ).	>40	20-40	<20	
Plant avail. water holding capacity (inches).	>10	6-10		
Texture of family control section.	l,cl, sil, sicl	all others	co sl & coaser	
Soil acidity of family control section (pH).	5.6-7.8			

dues and two slectricalinstaly 80% accuracy using that for the plants present. It is difficult to predict whilly because the presentint free that which formed but equations using the basal which, harte, and nose the status of organic and fertility - can be sative vegetation, but it deterning the degree of tic class.

ridefined. J. P. TANDARICES, filled, Univ. of lilinois at those Geological Survey.

Jo Soll Science from the 1970's was a lithologic disconstibulty the Deconcept was replaced in the Roman (Arabic since 1981) assesses a new use for the Disconcept is characterized in the Concept in the Concept is characterized in the Concept in the Concept is characterized in the Concept i

Soils of Kajondi farm of Burundi, Africa. B. A. TOUCHET\*,

R. ESPARAN and C. RAINIEU, Soil Conservation Service
Louisiana and D. C., and University of Burundi.

A soil survey of Kajondi farm, an International Benchmark
Sites Network for Agrotechnology Transfer (ISSNAT) Project,
was performed in October, 1983. Three (3) soil series sites
were sampled for characterization and seven (7) sites were
sampled for fertility profiles. According to 1. S. Soil Taxonomy four (4) of the people classified as 1ypic Acrohumou,
two (2) as Typic Haplohumox, one (1) as Typic Transsaprist.
and one (1) as TerricTroposaprist. Of the 401 hectares,
318 hectares are arable, 66 hectares are wet organic roils,
and 17 hectares are highly erodible soils. On display will
be the soil map of Kajondifarm, 2 crass-sections showing
the geomorphology and soils, photos of three soil profiles
and one landscape, and characterization data for the pedons.

The Proton Donor Theory: Part I. P. C. Ugolini, University of Washington, Scattle, WA.

Soil science lacks a unifying principle that explains soil processes. I propose that proton donors, saits and colloidal anions represent the unifying principle. Development of profiles is due to weathering and transporting processes. Proton donors or acids actuate weathering by liberation of protons that release ions from the soil matrix and provide conjugate bases for their transport. Saits size provide mobile anions as do the therged inorganic and organic colloids. The necure of the proton donors and approciate con-

L Goology and Geography.

Auto De Study Structurel

donors. Fulvic acid is the proton donor in the upper soil compartment of Spodomole where Fe and Al are depleted.

of abstract from beautite using the ellion toos of bauxite residue gen-15, are scored in large, diked, andreds of hectares in area. Conthat of vegetation in bauxite re-3 the ine hydraulic conductivity. pri consistency. Bauxite residuc the corry into scrylic perpendeters (b) so spendments. The residue was fire drainage and restricted drainthe sensageh was to study the deto because residue that was allowed delahout chemical abendments. endied by removing undiscorbed gers for thin section preparation. meline allowed wetting and drying to d∆le, porous, vell-aggregated stru el scalinge tenuited in a mansive

The Proton Donor Theory: Part 11. P. C. Ugolint, University of Machington, Sestite, MA.

I propose that proton donors, salts and collaids anions are the unifying principle to the genesis of salls. Development of profiles is due to weathering and transporting processes. Proton donors play the double role of providing protons for activating meathering as well as enions or conjugate bases for transport of extions in the sail solution. The identification and chemical behavior of proton donors and their conjugate bases are assential for understanding soil forwing and ecoaystem processes. This approach to padogenesis can be better achieved by lysimetry. Lysimetry studies of Spodosols have shown the existence of two chemical compartments dominated by different proton donors. Fulvic acid is the proton donor in the upper soil compartment. Cerbonic acid dominates the lower compartment. Fulvic acid spions fore sobile completes with Ye and Al, carbonic acid does not

By and BC where carbonic acid is the dominant proton donor.

the of the Dannke Archaeological Site: 1, 70. H.E. Tispeon, 4 R.G. Thompson, 1 E. Fora, N. D. State Bhiv., Univ. of sa Univ., and Univ. of Tennessee.

If the north of Fargo, MD, near the last Sheyenne rivers. The site is say of terraces sasociated with the Red Intentioustics in all profiles studied with an examination of soil screphology.

Doting Middle and Early Pleistocene Terraces Using Volcenic Ash. P. A. WARD III and B. J. CARTER, Oklahoma State

......

The Apiling Red Flains of western Oklahoms, Texas and Kanasa are motived by entensive areas of terrace deposits. The highest correct deposits extends across current major draituage divides and predominates uplend positions. Soils formed iron these terrace deposits support a high level agricultural production of winter wheat compared to testicual soils formed and a soils formed and a soils and a soils formed to testicual soils formed.

Modiana attitutes, therefore recovered from fiscal yielded 140 deter of 1850:80 (Sets-1: 5.F. (Sets-1:457) for the 80 and 110 cm with All dates are uncorrected radiometric cylestratizable F and K and DTA-extractable with correlate well with the pedologic mentified.

in age. Constructional geocorphic surfaces contain deep soils (Typic Peleustolis, Arenic Peleustelis, and Pachic Arginstolis) marked by additions of losss and solish sands. The dominant source for the ellictons terrace deposits is the Ogaliels formation of the Southern High Plains occurring west of the Rolling Red Plains.

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and markets

National Cooperative Soil Survey Work Planning Conference Maui, Hawaii June 16, 1988

> Report of Commit tee Six Laboratory Procedures

Committee Members Present:

W.R. Allardice Chair.

M. A. Fosberg

C.L. Ping

T. Soe be cki

A. R. Southard

Correspondence from;

W. Lynn - Analytical Precision

W.D.Nettl teon - Caloareous Samples and reporting of data

The charge to the committee continues as originally proposed. Some clarification of the charge is necessary and will be proposed under separate cover.

During the past two years the committee has monitored the results from the National Laboratory Comparison Study. Some results continua to be received and are not part of the accompanying report.

D. Nettleton requested the Committee **response** to his **concerns** on Caloareous soil 8. The committee **was** in **complete** agreement with his proposal and the proposal was presented as proposed to the conference..

The results of the Laboratory study were briefly discussed. In Summary the eleven labs participating in this study were unable to reproduce the results between labs within an acceptable range on some soils with some procedures. Refer to the special report for details. The SCS-Lincoln Lab was able to reproduce the data on their reference soil within 5% coefficient of variation in most years. The procedure for extractable acidi ty had a CV greater than 20% in 3 of the the 5 years examined in 20% 7346 Tc 4.15

standard procedures of the labs involve but were predominantly the specified procedures. Depending on the soil and method we found a rang\* of .4% to 189% CV. The high CV does not give one confidence in the results for that method1

The SCS bulletin board offers a first line means of communicating with other labs or users of the data if we make use of the system.

### Recomme Ada tions:

Establish a national soil standard (or Several) (1) that can be used by any soils lab to calibrate their operation and judge their performance.

(2) Adapt the recommendation of the NSSL oncal careous

soils.

National Cooperative soil Survey Work Planning Conference Maui, Hawaii June 1988

Special Report of **Committee** VI on Laboratory Procedures

by William R. Allardice

Committee VI has been responsible for conducting a study on the ability of soil laboratories to analyze a given set of soils by the standard soil survey methods with the resulting data comparable within the same population. This study was initiated in 1984 and has involved sixteen laboratories. Soils were provided by the laboratories listed in Table 1. The laboratories that analyzed the soils are identified with an asterisk. Table 2 lists the series name, horizon analyzed and the classification of the pedon from which the sample was obtained.

Our original goal was to have 20 laboratories analyze 20 soils with 4 replicas for three methods of cation exchange capacity, extractable cations, exchange acidity and texture (Table 3). We were fortunate to have 11 laboratories perform the analysis on 20 soils with 2 to 4 replications. The maximum number of samples that could be analyzed if all labs ran 4 reps was 44 total analyses per method.

The SAS institute's statistical analysis procedures were used to evaluate our data. The procedure, General Linear Models (GLM) was designed to handle unbalanced data which was the condition we faced because of the unequal replication of samples. Tests within GLM that evaluated the significance of the differences among means included Scheffe, Tukey and Bonferroni. Additional procedures that were used were Means, Univariate and Tabulate.

Table 4 is a general summary of the statistical data by sample for all laboratories. This table provides information on the mean, variance and standard deviation as well as the number of determinations that contributed to the mean. Table 5 provides a comparison of the mean and the median by soil for all laboratories. The mean is a measure of the central tendency of the population. When this parameter has a very large spread the reliability of the statistics are diminished. An alternative method of determining the central tendency is to use the median. As you can see from Table 5 the mean and the median are quite close for most analytical methods. Extractable acidity has more disagreement between the mean and the median than any other The median is a better measure of the central tendency of the population for extractable acidity. Table 6 provides an opportunity to determine which laboratories may be outside the "acceptable range of values". When this information is applied

to cation exchange capacity by the ammonium acetate method laboratory #33 is clearly apart from the central tendency determined by the other laboratories (see tables 5.7 and 6.7). Another example of conflicting results occurs with the extractable acidity. The mean for Lab # 41 was considerably lower than the mean for all other labs while the mean for lab # 51 was higher than other labs. The means for the remaining labs tended to form clusters. The wide range of means resulted in a high coefficient of variability and a greater spread between the mean and the median on some samples.

Our task becomes one of determining what amount of variation from the central tendency are we willing to accept; 10%, 5%, 1%? Should we be concerned about the variability? What accounts for the variability in our standard analyses? Further more how is one to recognize that their values may

more how is one to recognize that their values may

# NATIONAL COOPERATIVE SOIL SURVEY WORK PLANNING CONFERENCE MAUI, HAWAII

Table 1 Contributors and Participants in the Laboratory Analyses Project

\* Univ. of Alaska Palmer Ping, C. Univ. of Arizona Tucson Hendricks, D.M. \* Univ. of Calif. Davis Allardice, W.R. Carlisle, V.W. ★ Univ. of Florida Gainsville ★ Univ. of Guam Mangilao Demeterio, J.L. \* Univ of Hawaii Ikawa, H. Manoa \* Univ of Idaho Fosberg, M.A. MOSCOW Fenton, T. E. \* Iowa State Univ. Ames Purdue Univ. Indiana W.Lafayette Franzmeier, D.P.

\* Michigan Tech Univ. Were

\*

\*

Table 2

## NCSS WPC COMMITTEE VI

Index and Classification of Soil Samples smpl series horizon classification

- 2 Schmutz Bwy2 fine-loamy, gypsic mesic Ustic Torrifluvent
- 4 Nebeker B22t fine, montmorillonitic, mesic Pachic Argixeroll
- 6 Sipan Bt fine oxidic, isohyperthermic Oxic Paleustalf
- 8 Casa Grande Btk fine-loamy, mixed, hyperthermic Typic Natrargid
- 10 Sasco A coarse-silty, mixed. hyperthermic Typic Camborthid
- 12 Russell Bt fine-silty, mixed, mesic Typic Hapludalf
- 14 unavailable
- 16 Sasco B coarse-silty, mixed, hyperthermic Typic Camborthid
- 18 Holland Bt2 fine-loamy, mixed, mesic Ultic Haploxeralf
- 20 BS medial over loamy, mixed, frigid Typic Vitrandept
- 22 Lawnwood Bhml sandy, siliceous, hyperthermic,

Table 3 NCSS WPC
COMMITTEE VI
Laboratory Procedures Guide

Analytical Methods 31 33	35	37	LAB 39		43	45	47	49	51
EXT CAT NH4OAC (5A1- x x 5B1)	X	X	×	x		X	X		X
CEC	X		x	x	X		X	X	x
NAOAC (5A2a) x x							X		X
SUMCAT (5A3a) x	X	x		X	X	X	X		X
EXT ACDTY (6H1) x Kcl (6G1) H+	X	×		X X		X	X		X
TEXTURE (3A1) PIPETTE X -om -co3 CENTRIFUGE (3A1b)	X X X	X	X		X	X	X		<b>x</b> ×
HYDROMETER x			X						
рн х х	X	x		X		X			

Methods:

SSIR #1 rev. April 1972 and rev. August 1982

Table 4.1 SUMMARY OF STATISTICAL DATA FOR AMMONIUM ACETATE (pH 7.0) EXTRACTABLE CALCIUM

<b></b>				DAT	ra Ka			
	MEAN	VAR	STD	CV	STDE- RR	MIN	MAX	N
SAMPLE		r = = = = -						
2	193.1	4416	66.45	34.41	19.18	104.0	334.9	12.00
4	22.40	16.501	4.06	18.13	0.87	10.20	30.60	22.00
6	28.91	78.67	8.87	30.68	1.94	19.50	51.40	21.00
8	27.43	59.55	7.72	28.13	1.68	18.90	45.10	21.00
10	27.61	84.34	9.18	33.26	2.77	13.40	38.00	11.00
12	7.811	1.74	1.32	16.90	0.261	3.60	10.50	25.00
14	1.571	0.12	0.35	22.45	0.07	0.80	2.30	25.00
16	25.50	61.07	7.81	30.65	2.26	12.70	34.00	12.00
18	0.651	0.03	0.16	24.72	0.03)	0.301	1.00	22.00
20	6.411	1.50	1.23	19.14	0.27	2.80	8.70	21.00
22	0.041	0.00	0.05	129.1	0.021	0.001	0.10	10.00
24	0.551	0.04	0.20	36.77	0.041	0.101	1.40	29.00
26	2.091	0.221	0.47	22.56	0.14	0.90	2.80	12.00
28	11.48	1.431	1.20	10.44	0.24	9.20	14.20	24.00
30	8.681	5.791	2.41	27.71	0.98	1 4.20	11.00	6.00
32	2.151	0.141	0.37	17.36	0.08	1.601	3.00	21.00
34	3.51	0.331	0.57	16.33	0.13	2.90	5.20	21.00
36	119.741	1.631	1.28	1 6.471	0.39	17.60	22.20	11.00
38	0.49	0.01	0.09	19.00	0.02	0.30	0.70	25.00
40	113.291	6.83)	2.61	19.66	0.60	1 6.10	18.90	19.00
53	14.23	29.43	5.43	38.12	2.21	1 8.90	19.80	6.00

Table 5.1 AMMONIUM ACETATE EXTRACTABLE CATIONS MEANS AND MEDIANS FOR CALCIUM

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	12	193.117	66.4549	191.40
2	4	22	22.405	4.0616	23.00
3	6	21	28.914	8.8696	27.10
4	8	21	27.429	7.7169	24.40
5	10	11	27.609	9.1839	28.40
6	12	25	7.808	1.3194	8.00
7	14	25	1.568	0.3520	1.60
8	16	12	25.500	7.8148	26.95
9	18	22	0.645	0.1595	0.65
10	20	21	6.410	1.2267	6.30
11	22	10	0.040	0.0516	0.00
12	24	29	0.552	0.2029	0.50
13	26	12	2.092	0.4719	2.20
14	28	24	11.475	1.1976	11.50
15	30	6	8.683	2.4062	9.20
16	32	21	2.152	0.3737	2.20
17	34	21	3.514	0.5738	3.40
18	36	11	19.736	1.2777	19.50
19	38	25	0.488	0.0927	0.50
20	40	19	13.295	2.6131	13.50
21	53	6	14.233	5.4254	14.20

Table 6.1 SUMMARY OF MEANS BY SAMPLE AND LAB
FOR AMMONIUM ACETATE EXTRACTABLE CALCIUM

					LABS	** ** **			
	31	33	35	37	39	41	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
	меAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
SAMPLE									
2	•	231.1	334.9	174.7	108.7	•	•	•	219.5
4	10.20	24.00	24.47		25.40	23.12	22.40	17.97	23.75
6	•	29.77	•	38.27	36.10	19.85	26.47	20.60	37.10
8		33.13	•	38.23	21.73	20.50	24.37	22.50	37.05
10	•	26.50	•	36.77	15.20	•	•		34.15
12	3.601	8.231	8.371	8.201	9.771	7.351	7.401	6.601	8.25
14	0.801	1.631	2.001	1.071	1.531	1.621	1.831	1.271	1.95
16	16.70	26.10	•	34.00	16.73				29.40
18	0.301	0.601	0.701	0.631		0.551			0.95
20	2.801	7.531	7.101	6.301	6.871	•	•	5.171	7.10
22		0.	031	0.101		01	.   .		0.00
24	0.601	0.401	0.601			0.561	0.471	0.571	0.30
26	0.901	2.171	•	2.30		•	1.871		2.60
28		11.83	12.17	12.50	13.20	10.80	11.03	9.40	10.90
30		4.20	1 1	8.90	10.60	.	.	.   •	. .
32		2222001	2244001	2.431	2.031	1.751	1.801		2.80
34	·	3.331	4.071		3.601	3.301	3.201	3.03	4.45
36		19.30	19.60	-	21.10				18.55
38	0.301	0.571	0.571	0.401	0.501	1 0.501	1 0.50	1 0.43	0.50
40	6.10	13.80	13.97		14.97	12.40	12.70	.	15.30
53	 	14.23				.	•	.	. .

Table 4.2 SUMMARY OF STATISTICAL DATA FOR AMMONIUM ACETATE (pH 7.0) EXTRACTABLE MAGNESIUM

AMPLE	2.39	VAR 6.21	STI		CV	STDE- RR	MIN	MAX	N
AMPLE	+	6.21			+-			•	
	+	6.21			1	+**	+·		
	7 6/1		2.49	104	. 2	0.69)	0.901	9.10	13.0
	/.b4l	1.23	1.11	14.	<b>+-</b> 541	0.241	3.901		
~ * * * = * * * * * * * * * * * * * * *									

Table 5.2 AMMONIUM ACETATE EXTRACTABLE CATIONS
MEAN AND MEDIAN FOR EXTRACTABLE MAGNESIUM

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	13	2.39231	2.49248	1.20
2	4	22	7.64091	1.11127	7.90
3	6	24	2.02917	0.48766	2.20
4	8	21	2.59524	2.45509	1.90
5	10	13	0.92308	0.27735	1.10
6	12	25	4.47200	0.98511	4.50
7	14	25	0.18400	0.03742	0.20
8	16	14	0.72857	0.45477	0.70
9	18	22	0.57727	0.16015	0.60
10	20	21	0.60952	0.15781	0.60
11	22	10	0.00000	0.00000	0.00
12	24	29	2.78621	0.65286	2.70
13	26	12	0.56667	0.14355	0.60
14	28	24	5.18750	0.82109	5.25
15	30	7	2.31429	0.71514	2.70
16	32	21	1.07143	0.49310	1.00
17	34	21	3.00476	0.58947	2.90
18	36	11	7.17273	0.75643	7.50
19	38	25	0.08400	0.03742	0.10
20	40	19	5.44737	0.87646	5.60
21	53	6	4.48333	4.91179	4.45

Table 6.2 SUMMARY OF MEANS BY SAMPLE AND LAB
FOR AMMONIUM ACETATE EXTRACTABLE MAGNESIUM

					LABS				
	31	33	35	37	39	41	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
SAMPLE									
2				+ <u>-</u>		1. +		+	1.15
4	3.901	8.771 			l .	7.901		1 6.601 +	7.80
6	• •	2.601	2.471	2.371	2.331	1.401	1.80	1 1.431 +	2.05
8		3.431	• 	2.40	2.03	1.701	1.301	1.70	7.55
10		0.60	1.10	1.10	0.87		.		1.05
12	1.901	4.80	4.571	5.771	4.101	4.571	4.23	1 4.13	4.40
14	0.101	0.201	0.201	0.201	0.101	0.201	0.20	1 0.20	0.20
16	0.3	01 1.	071	0.801	0.701	L 0.5	01 .	[ - [ - [	0.75
18	0.301	0.671	0.601	0.771	0.401	0.551	0.571		0.60
20	0.201	0.771	0.571	0.671	0.501		0.60	1 0.63	L 0.70
22		0.0	001	0.00	1 0.	.001	.	-   -	0.00
24	1.30	3.10	3.07	4.101	2.171	2.55	2.73	2.701	2.75
26	0.201	0.631	•	0.7	01		0.5	01 .	0.55
28		5.831	5.471	6.601	4.001	L 5.331	5.03	1 4.60	L 4.30
30	1	.201	2.3	3	2.671	• [	.		
32		1.031	1.001	1.071	1.901	0.781	0.80	1	1.00
34	 	4.131	3.231				L 2.57	1 2.87	) 2.60
36	   	7.471	7.831	•	6.	•	.   .    -	.	7.25
38	0.00	0.101				0.101	0.07	1 0.10	0.10
40	2.90	6.33)	•	+	•	5.37)	5.67	1	5.45
53			4.4	81			•	.  .	,     •   •     •   •   •

Table 4.3 SUMMARY OF STATISTICAL DATA FOR AMMONIUM ACETATE (ph 7.0) EXTRACTABLE SODIUM

	   			DAT	PA			
	MEAN	VAR	STD	cv	STDE- RR	MIN	MAX	N
SAMPLE								
2	0.53	0.62	0.79	147.3	0.23	0.10	2.70	12.00
4	1.35	0.87	0.93	69.10	0.20	0.80	5.40	22.00
6	0.35	0.02	0.14	41.64	0.03	0.20	0.70	22.00
8	1.37	0.21	0.46	33.32	0.10	0.80	3.10	21.00
10	24.34	23.89	4.89	20.08	1.36	14.80	34.80	13.00
12	0.22	0.02	0.13	58.80	0.03	0.10	0.40	24.00
14	0.16	0.02	0.13	82.12	0.03	0.00	0.40	20.00
16	44.54	18.57	4.31	9.68	1.15	36.60	51.90	14.00
18	0.13	0.02	0.13	99.63	0.03	0.00	0.40	18.00
20	0.20	0.01	0.11	56.14	0.02	0.10	0.40	20.00
22	0.04	0.00	0.05	118.6	0.02	0.00	0.10	9.00
24	0.25	0.03	0.18	72.56	0.04	0.00	0.70	25.00
26	0.09	0.01	0.08	95.37	0.03	0.00	0.20	8.00
28	0.22	0.02	0.13	57.62	0.03	0.10	0.40	23.00
30	0.19	0.01	0.69	48.45	0.03	0.10	0.30	7.00
32	0.16	0.02	0.15	91.94	0.04	0.00	0.40	17.00
34	0.45	0.02	0.14	30.48	0.03	0.10	0.60	21.00
36	0.20	0.01	0.11	54.77	0.03	0.00	0.30	11.00
38	0.23	0.02	0.15	64.54	0.03	0.10	0.50	24.00
40	0.26	0.02	0.12	47.62	0.03	0.10	0.60	18.00
53	0.52	0.00	0.04	7.90	0.02	0.50	0.60	6.00

•		
1		

Table 6.3 SUMMARY OF MEANS BY SAMPLE AND LAB
FOR AMMONIUM ACETATE EXTRACTABLE SODIUM

					LABS				 
	31	33	35	37	39	41	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
SAMPLE					, — — — ·				
2	•	0.20	0.10	0.10 0.10	1.67		 		0.30
4	0.90	1.331	1.13	1 .	1.17	2.10	1.00	1.50	1.00
6	•	0.301	0.201	0.201	0.35	0.55	0.27	0.50	0.30
8		1.131		1.301	1.23	1.70	1.20	1.70	1.10
10	•	24.33	25.75	26.97	22.40		-		21.90
<b>1</b> 12	0.201	0.171	0.101	0.101	0.201	0.401	0.101	0.40	0.20
14	0.201	0.101	0.00	1 0.00	0.10	0.331		0.30	0.20
<b>1</b> 16	43.70	43.80	49.40	46.77	43.30	 	• 1	•   •	39.70
18	0.201	0.101	0.031	0.001	0.071	0.301			0.40
20	0.301	0.211	0.101	0.101	0.201	+ <del></del> -	0.101	0.401	0.30
2: 2	•	0.10	0	.001	0.00	•   •			0.10
2: 4	0.401	0.131	0.001	0.101	0.471	0.311	 •	0.401	0.10
2:6	0.201	0.101		0.001	•	+   .	•   •	+	0.20
2	<b></b>								
3									
3									
3									
3									
3									
4									
r .									

Table 4.4 SUMMARY OF STATISTICAL DATA FOR AMMONIUM ACETATE (pH 7.0) EXTRACTABLE POTASSIUM

		DATA							
	MEAN	VAR	STD	cv	STDE- RR	MIN	MAX	N	
SAMPLE					r — — — - 1				
2	0.46	0.00	0.05	10.97	0.01	0.40	0.50	13.00	

1.091 0.311

Table 5.4 AMMONIUM ACETATE EXTRACTABLE CATIONS MEAN AND MEDIAN FOR EXTRACTABLE POTASSIUM

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	13	0.46154	0.05064	0.50
2	4	22	0.41727	0.08125	0.50
3	6	24	0.47500	0.06079	0.50
4	8	21	0.41905	0.05118	0.40
5	10	13	1.78462	0.48278	1.60
6	12	25	0.24000	0.05000	0.20
7	14	24	0.02500	0.04423	0.00
8	16	14	1.09286	0.55534	0.85
9	18	22	0.17273	0.04558	0.20
10	20	21	0.55714	0.05071	0.60
11	22	7	0.00000	0.00000	0.00
12	24	29	0.10345	0.03254	0.10
13	26	12	0.11667	0.03892	0.10
14	28	24	0.33750	0.07697	0.30
15	30	7	1.02857	0.04880	1.00
16	32	21	0.30952	0.05390	0.30
17	3 4	21	0.11429	0.03586	0.10
18	36	11	0.79091	0.07006	0.80
19	38	24	0.03333	0.04815	0.00
20	40	19	0.34737	0.07723	0.40
21	53	6	0.48333	0.04082	0.50

Table 6.4 SUMMARY OF MEANS BY SAMPLE AND LAB FOR **AMMONIUM** ACETATE EXTRACTABLE **POTASSIUM** 

					LABS				
	31	33	35	37	39	41	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
SAMPLE	į			, , ,			,		
2	 +	0.47	0.50	0.40	0. 50	•		 	0.45
4	0.401	0.431	0.53		0.601	0.401	0.501	0.401	0.55
6	ļ .	<b>0.43</b> 31	<b>0.50</b> 1	0.501	0.571	0.401	0.501	0.471	0.45
8	į .	00.44001		0.401	0.501	0.401	0.401	0.401	0.45
10		1.5	01 1	.401	1.731	2.60	1	. .	1.45
12	0.20	1 0.23	L 0.30	1 0.27	1 0.30	1 0.20	0.201	0.201	0.25
14	0.00	0.101	0.001	0.001	0.101	0.001	0.001	0.001	0.00
16	0.7	01 0.	771	0.70)	0.971	2.1	01		0.85
18	i 0.10	1 0.201	0.201	0.201	0.171	0.101	0.201	• · · · · · · · · · · · · · · · · · · ·	0.20
20	0.501	0.531	0.53	0.50	0.601	•	0.601	0.57)	0.60
22		000001		Ø0001	•		- -		0.00
24	0.101	0.101	0.101	0.101	0.171	0.10	0.101	0.101	0.05
26	0.10	0.17)		0.101		•	0.10		0.10
28		0.331	0.401	0.301	0.401	0.23)	0.431	0.301	0.35
30	1	.001	1.0		1.071		•   •	.   .	
32		•	•	0.30		0.28	0.30		0.30
34		0.131	0.101		0.171	0.101	0.101	0.101	0.10
36		0.771	0.731	•	0.87				•
	<b>L</b> .								
53	İ								

Table 4.5 SUMMARY OF STATISTICAL DATA FOR BARIUM CHLORIDE /TEA (pH 8.2) EXTRACTABLE ACIDITY

				DAT	 	* *** *** *** *** ***		
	MEAN	VAR	STD	CV	STDE- RR	MIN	MAX	N
SAMPLE	++	+ 				+		
i]	5.00	35.52	5.96	119.2	1.721	0.00	17.50	12.00
4	4.91	19.90	4.46	90.86	1.00	0.00	16.70	20.00
6	6.971	23.581	4.86	69.66	1.181	1.40	17.20	17.00
8	2.03	14.66	3.83	189.0	0.881	0.00	15.90	19.00
10	3.581	23.611	4.861	135.71	1.541	0.00	15.20	10.00
.12	10.16	34.80	5.90	58.07	1.201	1.10	23.40	24.00
:14	12.52	43.82	6.62	52.86	1.381	0.50	25.70	23.00
16	3.39	12.70	3.56 1	L05.1	1.071	0.001	9.80	11.00
18	11.49	43.09	6.56	57.16	1.471	0.00	30.40	20.00
:20	23.36	51.67	7.19	30.77	1.65	16.20	40.00	19.00
:22	28.93	26.83	5.181	17.911	1.64	24.60	40.60	10.00
24	8.171	38.411	6.20	75.87	7   1.17	0.20	23.30	28.00
:26	5.13	26.43	5.14	100.2	1.431	1.00	14.70	13.00
:28	5.67	17.34	4.16	73.40	0.891	0.00	15.90	22.00
:30	1.121	0.671	0.82	72.92	0.371	0.301	2.30)	5.00
:32	8.821	32.691	5.721	64.811	1.311	0.10	21.80	19.00
:34	9.211	35.251	5.94	64.50	1.361	0.00	23.10	19.00
	†=== <del>-</del> †		-		<b>+</b> 7	r===-		,
,								
] : 								

Table 5.5 EXTRACTABLE ACIDITY BY

BARIUM CHLORIDE / TEA (PH 8.2)

MEANS AND MEDIAN

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN			
1	2	12	5.0000	5.9596	1.75			
2	4	20	4.9100	4.4612	3.40			
3	6	<del>1</del> 3	928399	4.8558	5.50			
4	8	<b>1</b> 9	2.0263	3.8291	0.60			
5	10	10	3.5800	4.8586	1.00			
6	12	24	10.1583	5.8989	9.50			
7	14	23	12.5217	6.6193	12.90			
8	16	11	3.3909	3.5644	2.30			
9	18	20	11.4850	6.5645	12.25			
10	20	19	23.3632	7.1880	21.60			
11	22	10	28.9300	5.1801	26.70			
12	24	28	8.1679	6.1972	9.40			
13	26	12	5.1308	5.1409	2.90			
<del>1</del> 3 14	28	10 22	5.6727	4.1641	120.24 498.48	Tm5	7.42	498.4

Table 6.5 SUMMARY OF MEANS BY SAMPLE AND LAB FOR BARIUM ACTIVE/TEA(pH8.2) EXTRACTABLE ACIDITY

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Table 4.6 SUMMARY OF STATISTICAL DATA FOR CATION EXCHANGE CAPACITY
BY SUB OF CATIONS AND EXTRACTABLE ACIDITY

				DAC	ГА			
	(MEAN	VAR	STD	CV	STDE-	MIN	MAX	N
SAMPLE						+ <u> </u>		
2	177.9	0.44	0.671	0.37	0.38	177.1	178.3	3.00
4	34.47	18.18	4.26	12.37	1.07	28.80	43.90	16.00
6	37.16	48.89	6.99	18.81	1.94	27.00	49.10	13.00
8	35.45	132.2	11.50	32.44	2.97	23.64	65.00	15.00
10	67.80	0.231	0.481	0.71	1 0.24	67.40	68.50	4.00
12	21.01	21.98	4.691	22.311	1.05	11.00	30.30	20.00
14	13.17	33.76	5.81	44.14	1.301	2.60	22.80	20.00
16	81.00	23.44	4.841	5.98	1 2.17	74.80	84.70	5.00
18	11.62	27.78	5.271	45.341	1.32	1.50	16.70	16.0
20	29.15	26.93	5.19	17.80	1.30	23.80	44.80	16.0
22	126.17	1 2.39	1 1.54	1 5.90	0.58	24.60	28.80	7.0
24	10.55	29.34	5.42	51.32	1.111	3.40	24.10	24.0
26	6.46	14.02	3.74	57.97	1.181	4.00	16.00	10.0
28	22.04	12.33	3.51	15.93	0.81	16.40	30.90	19.0
30	20.87	250.8	15.84	75.90	6.47	12.70	53.00	6.0
32	11.02	22.79	4.77	43.31	1.161	2.90	22.90	17.0
34	14.33	   16.51	4.06	28.35	<b>+</b> 1.021	+ L <i>6:::4</i> 0:	  1985100	₩ <b>6.</b> 20

Table 5.6 CATION EXCHANGE CAPACITY BY

SUM OF CATIONS AND EXTRACTABLE ACIDITY

MEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	3	177.867	0.6658	178.20
2	4	16	34.469	4.2636	34.90
3	6	13	37.162	6.9918	36.40
4 5	8	15	35.449	11.4999	36.10
	10	4	67.800	0.4830	67.65
6	12	20	21.015	4.6888	22.15
7	14	20	13.165	5.8105	14.40
8	16	5	81.000	4.8415	84.30
9	18	16	11.625	5.2709	13.10
10	20	16	29.150	5.1893	28.00
11	22	7	26.171	1.5446	25.80
12	24	24	10.554	5.4163	12.45
13	26	10	6.460	3.7450	4.95
14	28	19	22.042	3.5110	21.60
15	30	6	20.867	15.8371	14.55
16	32	17	11.024	4.7738	11.80
17	34	16	14.331	4.0630	14.70
18	36	8	36.263	4.7845	34.75
19	38	20	21.890	11.6465	23.35
20	40	13	24.192	4.5375	24.90
21	53	5	19.840	0.6656	19.70

Table 6.6 SUMMARY OF MEANS BY SAMPLE AND LAB FOR CATION EXCHANGE CAPACITY BY SUM OF EXTRACTABLE CATIONS AND ACIDITY

					LABS				
	31	33	35	37	39	41	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	•
	MEAN								
SAMPLE									
2									
4		, +-							
6		  -							
8		•							
10									
12									
114 									
1L6									
<u>  :</u>									
<u>-</u>									
<u> </u>									
<u> :</u>									
1									
1									
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:									
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Į:									
<u> </u> :									
4									
] <u>.</u>									

Table 4.7 SUMMARY OF STATISTICAL DATA FOR CATION EXCHANGE CAPACITY
BY AMMONIUM ACETATE

	I			DA'	TA			
	MEAN	VĄ	R S'	TD	ST CV R	DE-	, MAX	N
SAMPLE			i		<del></del>	- <del></del>		
2	7.49	12.62	3.55	47.44	0.86	4.20	14.70	17.0
4	32.31	29.24	5.41	16.74	1.10	24.20	46.10	24.0
6	15.68	20.24	4.50	28.70	0.96	10.80	29.70	22.0
8	11.64	15.42	3.93	133.731	0.901	7.60	18.60	19.0
10	15.73	14.22	3.77	23.96	0.89	11.90	26.50	18.0
12	18.44	19.96	4.47	24.23	0.91	12.80	32.30	24.0
14	8.85	7.32	2.71	- sant		—:—: <b>T</b> ==####_C==		gen and and and
16	25.52	12.54	3.54					
18	10.02	27.37	5.23					
20	21.99	23.59	4.86					
22	112.71	1 2.62)	1.62					
24	11.25	25.35	5.03					
26 	4.84	15.84	3.98	<del> </del> 				
28	18.11	10.02	~3.17					
		†	<del> </del>	+				

Table5.7CATION EXCHANGE CAPACITYBY AMMONIUM ACETATEMEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	12	5.5250	0.79187	5.65
2	4		30.7100	3.78127	30.35
3	6	20 18	14.3222	2.30218	13.95
4	a	15	10.7733	3.43708	9. 10
3 4 5	10	13	14.0769	1.84984	13.90
6	12	20	16.9600	1.98054	17. 25
7	14	20	8.1450	1.02338	7. 95
8	16	12	23.9833	2.23763	24.00
9	18	18	8.7611	4.09234	7.50
10	20	17	20.8235	4.31067	18. 90
11	22	9	12.7111	1.61976	12.50
12	24	24	9.8000	1.57866	9.45
13	26	1	2.1571	0.19881	2.80
14	3 Ô	20	17.5500	2. 31982	18.00
15	32	17 3	10.8333	0.66583	10.50
16	<b>3</b> -	v	8. 5412	1.66172	8. 10
17	34		10. 2200	3. 33807	9. 45
18	36	20 14	29.0786	2.73922	30. 15
19	38	20	13. 7800	2.79729	13.60
20	40	15	20.7467	1.63963	21. 20

Table 6.7 SUMMARY OF MEANS BY SAMPLE AND LAB FOR CATION EXCHANGE CAPACITY
BY AMMONIUM ACETATE

	   				- <del></del> -			LA	BS	****							
	3	1	3	3	3	5	37	39	41 41		45	<u> </u>	47	<u> </u>	49		51
	DA	TA	DA	TA	DA'	ГА	DATA	DATA	DAT	Α	DAT	'A	DAT	Α	DAT	A	DATA
	м	MEA	N	AN	ME	AN	MEAN	MEAN	MEA	.N	MEA	N	MEA	N	MEA	N	MEAN
SAMPLE													r —		,		
2	.	12.	20	5.	60		5.90		\ .				L	5.	75		5.18
l	 		40	.00	33	. 53	. [	35.77	25.	77	 		30.	23	29.	90	30.78
)	<u> </u> ₊		21	.77	13	.60		17.20	13.	53	İ 	•	16.	40		<b>,</b>	12.42
3	<u> </u>		14	.90	 	•		16.47	7.	901	, 	•	12.	20	<u> </u>	•	8.80
10	<u> </u>	•	20	.04	13	.80	!	14.27	<u> </u>		<u> </u>		L	•	12.	00	14.77
12	 <del> </del>		25	.85	17	. 63		19.20	13.	77	<u> </u>	•	18.	43	17.	20	16.78
!4	<u> </u>		13	.57	7.	.73		9.03	6.	75L	, - 	•	11.	13	8.0	)5	7.22
۱6			29	.20	25	40		25.73	 	•				•	21.	10	23.52
18	ļ 		14	.54	7.	67		12.57	7.	50	<u> </u>	•		•	8.	90	8.20
30	 		26	.92	17	.77		22.50		•		•	28.	00	18.	80	18.60
<u> </u>	<u> </u>		ļ 		14	. 33	. ;			•	<u> </u> 				ļ	•	11.90
24	 <del> </del>		19	.95	8.	931		11.83	9.	461		•	12.	43	9.4	101	8.22
16	 <b>!</b>		<u> </u>		8.	481		.  .	į .		.	•			2.	751	2.76
38	 		20	.90	18	.20	 	20.57	14.	23	 	•	19.	40	16.	40	17.36
10	ļ 		20	.30	10	83			ļ 	•	ļ 	•			 	•	
32	 		13	.25	7.	631		10.83	8	. 7	51 +	•			9.0	001	7.36
14	 		22	.67	9.	.00		15.40	9.	42	<u> </u>		12.	97	ļ 	•	7.80
16	 		40	.17	30	. 23		33.70	   	•	   	•			27.	80	28,48
18	,	# 	21	.37	11	93		16.83	15.	65	   		11.	50	13.	85	12.90
10	 <b> </b>		27	.75	21	.47		22.73	18.	73	,	•	,	•	 	•	20.74
53	j	-	23	.80			. !	•			   	•	) 		İ		

Table 4.8 SUMMARY OF STATISTICAL DATA FOR CATION EXCHANGE CAPACITY
BY SODIUM ACETATE

				DAT	ΓA			
	MEAN	VAR	STD	cv	STDE-	MIN	XAM	N
SAMPLE			<del>-</del>	   		 	<sub> </sub>	, 
2	8.83	0.70	0.84	9.46	0.34	7.80	10.10	6.00
4	34.75	12.83	3.58	10.31	1.13	31.80	44.40	10.0
6	22.96	24.95	4.99	21.76	1.66	18.10	31.20	9.0
8	11.01	4.56	2.13	19.39	0.71	9.10	14.00	9.00
10	17.43	3.18	1.78	10.23	0.73	15.80	20.60	6.00
12	20.03	4.281	2.07	10.33	0.65	17.90	25.40	10.0
14	10.35	7.25	2.69	26.00	0.81	L 5.80	14.60	11.0
16	28.31	8.52	2.92	10.31	1.03	25.90	33.10	8.0
18	12.49	2.74	1.66	13.27	0.63	11.00	16.00	7.0
20	26.94	56.74	7.53	27.96	2.27	16.30	37.10	11.0
22	20.14	1.56	1.25	1 6.211	0.47	17.70	21.80	7.0
24	12.41	13.74	3.71	29.87	1.12	7.10	18.30	11.0
26	4.021	0.321	0.56	13.98	0.20	1 3.30	1 5.20	8.0
28	122.34	1 7.031	2.65	11.87	0.84	18.60	25.90	10.0
30	11.38	0.00)	0.05	0.44)	0.03	11.30	11.40	4.0
32	15.15	11.56		+	+	+	<b>∱</b>	+

Table 5.8 CATION EXCHANGE CAPACITY
BY SODIUM ACETATE
MEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	6	8.8333	0.83586	8.70
2	4	10	34.7500	3.58244	33.65
3	6	9	22.9556	4.99478	19.80
4	8	9	11.0111	2.13450	9.90
5	10	6	17.4333	1.78288	16.75
6	12	10	20.0300	2.06992	19.45
7	14	11	10.3545	2.69235	11.00
8	16	8	28.3125	2.91863	27.10
9	18	7	12.4857	1.65673	12.10
10	20	11	26.9364	7.53250	29.00
11	22	7	20.1429	1.25014	20.10
12	24	11	12.4091	3.70714	13.50
13	26	8	4.0250	0.56252	4.05
14	28	10	22.3400	2.65213	22.80
15	30	4	11.3750	0.05000	11.40
16	32	6	15.1500	3.41453	15.05
17	34	9	12.5778	3.45318	12.10
18	36	6	32.8167	3.59078	31.45
19	38	10	19.1700	9.07243	22.40
20	40	7	23.5571	2.68878	22.70
21	53	6	16.9833	1.03037	16.85

Table 6.8 SUMMARY OF MEANS BY SAMPLE AND LAB
FOR CATION EXCHANGE CAPACITY BY
SODIUM ACETATE

	31	33	135	37	39	41	45	47	51
			DATA	DATA	DATA	DATA	DATA	DATA	∔  DATA
	MEAN	(MEAN	MEAN	MEAN -w-v-	1EAN	MEAN	1EAN		
AMPLE				-w-v-					
		8.93	. 1		• :	1		ļ	
	32.10	33.90		.		.	•	<del>!</del> [	
~~~~	•	20.17	 			   •	•	<del> </del>	
	•	9.5	+ 71 .	   .	.			•	
.0		16.33	•		} ~	}   •		<del>‡</del>	
.2	19.00	18.63	•	+	+	+	<b>-</b> •		
4	10.20	11.43	.	   ,	}· 	} }	·. 		
.6	25.90	27.20	ŧ↓ 	·		+	٠.		
.8	11.00	11.80	 	+ 	•	+			
0	27.10	28.87	+   .	}   .	+· 	+ 			
22	+·	19.40	+ 	+ •	•	+			

Table 4.9 SUMMARY OF STATISTICAL DATA FOR PH

]			DATA								
		MEAN	VAR	STD	CV	STDE- RR	MIN	MAX	N		
		r		r							
	SAMP						6.90	7.80	3.00		
4		7.811	0.221	0.471	6.051	0.151					
6		7.901	0.031	0.171	2.141	0.061	7.501	8.001	8.00		
8		8.131	0.161	0.401	4.961	0.161	7.501	8.501	6.00		
10		9.301	0.131	0.361	3.881	0.211	9.001	9.701	3.00		
12		5.061	0.021	0.131	2.501	0.041	4.801	5.30	10.00		
14		5.451	0.021	0.141	2.631	0.051	5.201	5.70	10.00		
16		9.851	0.011	0.101	1.02)	0.051	9.80	10.00	4.00		
18		5.891	0.041	0.201	3.461	0.081	5.601	L 6.201	7.00		
20		6.301	0.011	0.101	1.591	0.031	6.201	L 6.501	9.00		
22		4.33)	0.001	0.061	1.331	0.031	4.301	4.401	3.00		
24		5.421	0.041	0.201	3.771	0.061	5.201				
26	1	5.531	0.041	0.211	3.761	0.121	5.301	5.701	3.00		
28	i	6.681	0.001	0.041	0.661	0.011	6.601	L 6.701	9.00		
30		7.841	0.021	0.151	1.931	0.071	7.701		5.00		
32		5.82		0.171					6.00		
34		6.381	0.061	0.251	3.901	0.081	5.901	6.801	9.00		
36		5.951	0.101	0.311	5.231	0.16)	5.501	[ £_2 <u>1</u> 0	)		
									>		
									•		
									)		

Table 5.9 PH MEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
<b>1</b> 2	2	3 10	7.46667 7.81000	0.49329 0.47246	7.70 7.90
3	6	8	7.90000	0.16903	7.95
4 5	8	6	8.13333	0.40332	8.20
	10	3	9.30000	0.36056	9.20
6	12	1 0	5.06000	0.12649	5.10
7	14	1 0	5.45000	0.14337	5.45
8 9	16	4	9.85000	0.10000	9.80
	18	7	5.88571	0.20354	5.80
10	20	9	6.30000	0.10000	6.30
11	22	3	4.33333	0.05774	4.30
12	24	11	5.41818	0.20405	5.40
13	26	3	5.53333	0.20817	5.60
14	28	9	6.67778	0.04410	6.70
15	30	5	7.84000	0.15166	7.80
16	32	6	5.81667	0.17224	5.80
17	34	9	6.37778	0.24889	6.40
18	36	4	5.95000	0.31091	6.05
19	38	1 0	5.53000	0.11595	5.55
20	40	7	5.95714	0.22991	6.00
21	53	1	7.80000		7.80

Table 6.9 SUMMARY OF MEANS BY SAMPLE AND LAB FOR pH

		· <del></del>			LAI	BS				
	31	33	35	37	39	41	43	45	47	51
	DATA	DATA	DATA	DATA	(DATA	DATA	DATA	DATA	DATA	DATA
	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
AMPLE				<b>\$~ \$** 6** 6** 6**</b> ***		† <b></b>			+	+
,		7.70	7	.351		.I	, •	ı.	Į.	I
·	7.30	7.00	L 8.2	31	 	8.00	7.401		7.9	01
; ;	I .		7.7	71		8.001			7.9	71
	I .		,	•		7.501	8.001		8.4	
LO	I •	9.00	;	9.4	151	+	•	-   -	+	٠,
12	5.10			.01	_	5.301			5.0	
L4	5.60	5.70	; 	•	•	5.301	-	•	5.5	•
6	9.80	9.801	9.901	,			•			
L8	T			,	r	T	r	r=====	T	T

Table 4.10 SUMMARY OF STATISTICAL DATA FOR THE PARTICLE SIZE CLASS SAND

				'AG	ra		
	MEAN		STD			<del></del>	
	MEAN	VAR	ן אונא ן			1	ı
SAMPLE							
۷.							
4							

Table 5.10 PARTICLE SIZE CLASS SAND MEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	11	23.0818	12.5470	27.50
2	4	23	9.5870	2.5099	9.00
3	6	24	13.8750	3.7276	13.45
4	8	22	60.1318	4.3819	60.60
5	10	14	41.9143	3.4216	41.95
6	12	26	8.7115	2.5939	8.10
7	14	26	82.3923	1.6358	82.55
8	16	15	23.4400	2.1152	23.30
9	18	23	18.1913	3.5366	17.50
10	20	23	25.1000	5.4011	26.60
11	22	10	84.8600	15.0634	89.50
12	24	29	16.1345	1.5678	16.60
13	26	14	36.7643	3.9805	35.90
14	28	25	3.7720	2.3648	3.30
15	30	7	66.4429	2.5664	66.00
16	32	22	13.1545	3.6641	12.30
17	34	22	1.4227	1.8116	0.55
18	36	12	2.0333	0.6880	2.00
19	38	26	37.1615	4.8750	37.65
20	40	20	5.8450	2.2714	4.95
21	53	4	60.8000	1.4024	61.05

					LAI	3S				
	31	33	35	37	39	41	43	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
	mean (	mean (	mean (	mean (	MEAN (	MEAN (	MEAN (	MEAN (	( MEAN (	MEAN
SAMPLE					,	<b>? = =</b> • ·			+ ···	
2		4. 2	5 <b>35</b>	.80 29	.43	26.37	1 .	$\lfloor \cdot \rfloor \cdot \rfloor$		6.40
4	7.001	8.571	7.131		6.83	13.57	7.901	9.83	12.80	9.80
6		10.17	20.43	18.20	12.73	11.03		14.00	9.87	14.57
В	i i	63.90	•	55.77	58.53	54.27	54.40	61.37	65.53	63.47
10	i •	42.23	45.25	38.40	39.10		ļ .	ļ	ļ .	45.70
12	i 10.00	7.17	1 6.77	1 7.67	1 5.30	11.57	6.70	1 8.87	13.20	9.40
14	85.00	81.57	83.87	82.37	82.73	80.67	79.70	81.80	84.13	82.03
16	23.00	24.73	23.65	21.47	21.30		 	+ 		26.27
18	15.00	18.73	23.17	23.27	14.60	17.17	17.50	13.93	·	17.77
20	28.00	23.20	28.50	26.53	15.87	+ 	+	+	+	+

Table 4.11 SUMMARY OF STATISTICAL DATA FOR THE PARTICLE SIZE CLASS SILT

			· · · · · · · · · · · ·	DA'	ГА			
	MEAN	VAR	STD	CV	STDE-	MIN	MAX	N
SAMPLE					<b>F</b>		r	
2	60.89 60	.89 111.7	10.57	17.36	3.19	45.20	86.20	11.00
4	42.76	15.26	3.91	9.14	0.81	34.30	47.50	23.00
6	128.79	1116.8	10.81	37.54	2.21	11.10	45.00	24.00
8	16.96	38.39	6.20	36.53	1.32	11.10	30.90	22.00
10	44.16	21.71	4.66	10.55	1.25	38.80	54.90	14.00
12	59.67	22.61	4.751	T.97	0.93	49.50	66.60	26.00
14	113.19	1 4.121	2.03	15.40	0.401	L 9.00	16.50	26.00
16	59.23	19.84	4.45	7.52	1.15	54.30	68.80	15.00
18	41.44	34.20	5.85j	14.11	1.22	32.10	52.50	23.00
20	67.77	17.76	4.21	6.22	0.88	57.40	73.50	23.00
22	10.88	235.5	15.35	141.0	4.85	4.00	54.40	10.00
24	12.52	14.47	3.80	30.39	0.71	7.40	122.40	129.00
26	(53.84	115.451	3.93	7.30 j	1.05	47.20	59.70	14.00
28	66.46	15.02	3.88	5.83	0.78	57.70	70.90	25.00
30	115.311	3.471	1.86	12.16	0.70	13.00	18.00	7.00
32	36.77	26.38	5.14	13.97	1.10	27.00	43.90	22.00
34	14.95	24.34	4.93	33.00	1.05	L 6.50	23.10	22.00
36	58.92	3.481	1.861	3.171	0.54	54.60	61.70	12.00
38	56.97	18.89	4.35	7.63	0.85	49.20	65.20	26.00
40	64.98	20.10	4.481	6.901	+ -	+ <del>-</del>	+	+

Table 5.11 PARTICLE SIZE CLASS SILT MEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	11	60.8909	10.5697	59.60
2	4	23	42.7565	3.9059	42.70
3	6	24	28.7917	10.8074	25.65
4	8	22	16.9591	6.1958	14.50
5	10	14	44.1571	4.6593	42.10
6	12	26	59.6654	4.7550	60.65
7	14	26	13.1885	2.0304	13.35
8	16	15	59.2333	4.4540	59.00
9	18	23	41.4391	5.8481	40.70
10	20	23	67.7739	4.2141	68.70
11	22	10	10.8800	15.3456	6.60
12	24	29	12.5172	3.8039	11.50
13	26	14	53.8357	3.9309	54.65
14	28	25	66.4600	3.8761	67.30
15	30	7	15.3143	1.8623	15.20
16	32	22	36.7727	5.1364	37.80
17	34	22	14.9500	4.9337	13.65
18	36	12	58.9167	1.8649	59.00
19	38	26	56.9731	4.3460	57.20
20	40	20	64.9750	4.4834	65.90
21	53	4	23.0500	1.8193	22.85

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	ar van van -to, 4-n, 4-n, 4-n, 4-n, 4-n, 4-n, 4-n, 4-n	·····································

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Table 4.12 SUMMARY OF STATISTICAL DATA FOR THE PARTICLE SIZE CLASS CLAY

	 		· • • • • • • • • • • • • • • • • • • •	DA7	îA		· • ·	
	MEAN	VAR	STD		STDE-		MAX	N
SAMPLE	    	   						*     
2	16.02	157.2	12.54	78.28	3.78	1 3.80	38.20	11.00
4	147.67	1 4.32	1 2.081	4.361	0.43	44.60	52.20	23.00
6	57.33	195.5	13.98	24.39	2.85	33.90	78.10	24.00
8	22.90	24.42	4.94	21.58	1.05	13.30	31.20	22.00
10	113.93	31 <b>5.6</b> 8	8   2.38	17.11	0.64	1 9.80	17.60	14.00
12	31.62	10.54	3.25	10.27	0.64	25.90	38.60	26.00
14	4.41	1 2.89	1.70	38.57	0.33	1 1.20	8.00	26.00
16	17.34	9,45	3.07	17.73	0.79	10.50	20.10	15.00
18	40.37	65.26	8.08	20.01	1.68	25.10	50.40	23.00
20	7.12	12.79	3.58	50.21	0.75	1.60	14.20	23.00
22	4.28	1 0.55	0.74	17.37	0.24	1 3.20	5.20	10.00
24	71.34	17.82	4.221	5.921	0.78	61.00	80.20	29.00
" " " " " " " " " " " " " " " " " " " "	-		1.32	•	•	) 6.80	13.00	14.00
28	(29.75	51 9.4	21 3.07	10.32	0.61	26.90	37.40	25.00
30	18.23	2.001	1.421	7.761	0.53	•	•	7.00
32		43.32	6.58	13.15	1.40	38.00	59.30	•
		47.24	6.871	8.171	1.47	70.10	93.00	22.00
36	39.04		1.88	•	-	_		•
38		23.98	4.90	83.70	0.96	1.20	17.20	26.00
40		8) 5.9	1) 2.4	8.3	3) <b>0.5</b>	4   24 . 4	0 34.20	20.00
53	16.15	0.19	) 0.44	1) 2.7	0) 0.2	2 15.6	0 16.50	0 4.00

Table 5.12 PARTICLE SIZE CLASS CLAY
MEANS AND MEDIANS

OBS	SAMPLE	NUM	MEAN	STD	MEDIAN
1	2	11	16.0182	12.5390	12.20
2	4	23	47.6696	2.0794	47.50
3	6	24	57.3292	13.9821	63.15
4	8	22	22.9000	4.9421	22.55
5	10	14	13.9286	2.3831	14.65
6	12	26	31.6192	3.2458	31.20
7	14	26	4.4077	1.6999	4.15
8	16	15	17.3400	3.0738	18.00
9	18	23	40.3652	8.0785	42.50
10	20	23	7.1217	3.5757	6.60
11	22	10	4.2800	0.7436	4.45
12	24	29	71.3379	4.2214	71.40
13	26	14	9.4000	1.3214	9.15
14	28	25	29.7520	3.0691	28.50
15	30	7	18.2286	1.4151	18.30
16	32	22	50.0682	6.5819	50.85
17	34	22	84.1591	6.8728	85.95
18	36	12	39.0417	1.8754	38.35
19	38	26	5.8500	4.8965	4.65
20	40	20	29.1850	2.4310	28.65
21	53	4	16.1500	0.4359	16.25

IABS  31   33   35   37   39     43   45    DATA   DATA   DATA    MEAN   MEAN   MEAN   MEAN    MPLE	31   33   35   37   39     43   45    DATA   DATA   DATA   DATA   MEAN
DATA   DATA   DATA   DATA   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   ME	DATA   DATA   DATA   DATA   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   ME
MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   ME	MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   MEAN   ME
. 36.35 8.15 5.13	. 36.35 8.15 5.13
+++++	++++++
. 49.37	
. 49.37	. 49.37  ++ ++
, , , , , , , , , , , , , , , , , , , ,	

Table 4.13 SUMMARY OF STATISTICAL DATA FOR CATION EXCHANGE CAPACITY
BY BARIUM CHLORIDE /TEA (pH 8.2)/GYP

_					DAT	'A				
	MEAN	VAF	R S	TD	C	V ST	DE- R	MIN	MAX	N
SAMPLE					+					
2	0.90	.		.	+	0.	90	0.	90	1.00
4	36.07	2.401	1.55	l 4.	301	0.90	34.	50 3	7.60	3.00
6	27.23	0.401	0.64	1 <b>2.</b>	33	0.37	26.	50 2	7.60	3.00
8	9.871	1.331	1.15	11.	70	0.67	1 9. +	20   1	1.20	3.00
10	15.20	3.61)	1.90	12.	50	1.10	13.	60 1	7.30	3.00
12	121.431	0.08	0.29	l 1. <b>!</b>	351 +	0.17	21. 	10 2	1.60	3.00
14	14.70	0.25)	0.50	) 3. <b>+</b> -	401	0.29	14.	20 1	5.20	3.00
16	121.531 <b>+</b> +-	2.961	1.72	1 7. +	991	0.99	20.	30 2	3.50	3.00
18	14.30	3.01	) 1.73	;   12	.13	1.00	   12 	40 1	5.80	3.00
20	28.07	0.331	0.58	2.	061	0.33	27.	40 2	8.40	3.00
22			-   -	· 	+		+	+-		0.00
24	12.90	0.121	0.35	l 2. <del>!</del>	691	0.20	12.	50   1	3.10	3.00
26	2.33)	1.33)	1.15	49.	49	0.67)	1. +	00)	3.00)	3.00
28	21.70	0.001	0.00	0.	001	0.00	21.	70 2	1.70	3.00
30	11.03	1.08)	1.04	19.	431	0.60	10.	20 1	2.20	3.00
32	113.631	0.961	0.98	7.	201	0.57	12.	50 1	4.20	3.00
34	15.50	0.48	0.69	4.	47	0.40	15.	10 1	6.30	3.00
36	33.17	0.89	0.95	1 2.	851	0.55	32.	10 3	3.90	3.00
38	32.70	0.791	0.89	2.	721	0.51	32.	00 3	3.70	3.00
40	24.90	1.211	1.10	1 4.	421	0.64	23.	80 2	6.00	3.00
53	18.33	0.651	0.80	4.	39	0.33	16.	90 1	8.90	6.00

Table 5.13 SUMMARY OF MEANS AND MEDIANS FOR CATION EXCHANGE CAPACITY BY BARIUM CHLORIDE /TEA(pH 8.2)/GYP

OBS	SAMPLE	NUM	MMEAN	SSTD	MMEDIAN
1	2	1	0.9000		0.9
2	4	3	36.0667	1.55027	36.1
3	6	3	27.2333	0.63509	27.6
4	8	3	9.8667	1.15470	9.2
5	10	3	15.2000	1.90000	14.7
6	12	3	21.4333	0.28868	21.6
7	14	3	14.7000	0.50000	14.7
8	16	3	21.5333	1.72143	20.8
9	18	3	14.3000	1.73494	14.7
10	20	3	28.0667	0.57735	28.4
11	22	0	1	•	•
12	24	3	12.9000	0.34641	13.1
13	26	3	2.3333	1.15470	3.0
14	28	3	21.7000	0.00000	21.7
15	30	3	11.0333	1.04083	10.7
16	32	3	13.6333	0.98150	14.2
17	34	3	15.5000	0.69282	15.1
18	36	3	33.1667	0.94516	33.5
19	38	3	32.7000	0.88882	32.4
20	40	3	24.9000	1.10000	24.9
21	53	6	18.3333	0.80416	18.7

Table 6.13 SUMMARY OF MEANS BY SAMPLE AND LAB FOR CATION EXCHANGE CAPACITY BY BARIUM CHLORIDE/TEA(pH 8.2)/GYP

					LABS				
	31	33	35	37	39	41	45	47	51
	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN	
SAMPLE 									
:2									
4					 +				
15 									
13									
10									
<u> </u> :									
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## AGFNCY REPORTS

## BUREAU OF LAND MANAGEMENT

Colin Voight was selected to fill the Washington Office soil scientist position that has been vacant since Jim Stone moved to Phoenix, Arizona. Incidentally, Jack Chugg now resides in Coeur d'Alene, Idaho during the summer and in Arizona during the winter. Colin sends his regrets for being unable to attend this meeting.

Colin has identified fine areas the RIM will pursue in the soils program.

- 1. Determine the status of soil survey on Bureau administered land. This information will include, by state, acres of public land with soil survey, acres remaining to be surveyed, the order of each survey, determine if survey was correlated with the NCSS, determine if survey was digitized, and list the intended primary use of the survey. Results of the status report will be used to set priorities for those areas remaining to be surveyed. Rough estimates show that, excluding Alaska, about 128 million acres or 18 percent of BIM administered lands remain to be surveyed.
- 2. BIM soil survey data are designed for the user groups of the public domain lands. Thus, the interpretations, including vegetation data, will need to be in an easily understood form and meaningful to BIM managers in order to achieve maximum usability.
- 3. Work toward the goal of automating Bureau soil survey data. We want existing data to be easily accessible to those interested in its use. This includes data entered in various SCS data banks. There are a few soil survey naps being entered into GIS systems. Close coordination will be necessary to assure sane sort of software compatibility among the agencies. This may be like chasing a rainbow, but we should start the effort now.
- 4. In addition to interagency correlation in GIS, we would like to see interagency cooperation in the necessary research to better quantify affects of erosion on forest and rangeland productivity. We also need a method of effectively and economically measure erosion quantitively.
- 5. Providing soil services to managers in such a manner that it aids in their jobs is a prime task for all soil scientists. The technology transfer success in the Bureau has been at various levels. This is a major concern. Soils positions in the Bureau, like most other agencies, are on the decline. Is this decline caused by our inability to communicate, to provide needed to wanted data, or political direction? No matter what the answer, the NCSS needs to be strong technically and politically and provide services desired by progressive managers. BIM looks forward to continue working as a partner in NCSS.

Application of Expett Systems to Soil Resource Management Western Pegronal Soil Survey Conference Naci, Hawaii, June 18-17, 1988

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### Introduction:

Two kinds of soil information continue to be in short supply: 1) soil data to support quantitative accels and regional displays of soil properties, and 2) advice and recommendations on the implications of soil properties for planning and design.

Soil data are required at many scales--varying from a few maters to assess certain types of proundwater contomination to bilometers to assess regional impact of landuse practice on waterstees. Whereas soil data was collected for the purpose of classification, we sometimes now use the classification to extrapolate or infer soil properties (Yout and Fox, 1981). In addition, the reliability of the feil data are increasingly becoming part of groundwater contamination assessment methodology (Green et al., 1988).

The need for espect advice and recommendation is becoming more widespread as well. Preplanced recommendations and testbook interpretations, while useful, are often inadequate to develop an optical strategy for using sail resources. To develop the best possible recommendation often requires the full expertise and hoowledge of the soil scientist to take advantage special conditions in some cases and to work around special limitations in others. There are far the few of such individuals available either locally or nationally to work with interdisciplinary teams to design and develop optimal strategies. What is needed is not only the knowledge and information of the experienced soil scientist but the interaction of that knowledge with other disciplinary information relating to the other constraints of the problem, the situation, or of the design.

We believe that these conditions require a re evaluation of soil information collection, management, and dissemination. We shall discuss some aspects of information acquisition and dissemination in this paper. While the element ways to acquire and disseminate soil resource information, we believe that the application of expert systems has exciting potential to accomplish the objectives of SCS.

### Expert Systems

Expent existence are an information management technology with rapidly proving applications in accepte and business. Although research in artificial intelligence to subdiscipline of computer science; has been conducted for some 10 years it has only been with the advent of the microcomputer that this technology has brooke viable for the scientific community.

Applications include a surprisingly wide range of topics such as; diagnosis of medical disease, configuring of computers (determining what assortment of drives, memory, ports, and software are needed for particular applications), evaluating research proposals, testing segments of highly technical engineering systems to space research, and identifying soybean diseases.

At first glares such a variety of applications may seem overly impressive. The essential characteristic of these expect systems, however, is that they are classificators, that is, they start will general information and with the addition of new data (obtained from the user) they harrow down to a particular grouping, conclusion or recommendation according to rules and relationships present in the knowledgebase.

These groupings, combinations or recommendations represent the judgement of the expert whose incolledge the system represents. The quality of recommendations developed by such systems is determined first by the quality of the experts incolledge one second by the accuracy with which it is represented in the system.

The most reconstruct part of report systems is probable the sace with start a variety of information can be represented and used in decision-making. This variety of information ranges from quantitative information including statistical relationships such as regression countries and physical or changes "laws" (countimes referred to as "algorithmic" information; to less precise peneral rules of thumb or hunches that have been developed from bardons and experience in the field twometimes referred to as "heuristic" informations. The latter type of information can now be preserved and utilized in a more systematic may.

Expert systems rechanlogy is also particularly appropriate to view of the variety of interdisciplinary information needed to effectively problemsolve in complex acricultural systems. Some of the expected applications of this technology include benefits to both research and extension.

I. Pessauch: Research and experience in acid soils developed in selected areas of research excellence in Africa. C. America, and Asia can be captured, explorted, and shared throughout other research centers in the tropics which could increase the performance and efficiency of new research staff by building on previous research tather than duplicating it. Research methodology as well as results could be shared by this method. For example, researchers at the University of Florida have used expert systems to ease the setup and control of growth chambers for research screentists.

A. Aprilication of research: While expert systems use computer languages

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conclusion or recommendation is open to scrutiny and is not buried in computer code such as BASIC. FORTROM, C. PASCAL, etc. In fact, the literature citation of personnel communication which supports a conclusion or segment of rationale can be displayed by many systems. This form of 'transparency' can be an effective technology transfer tool.

### Examples of expert systems using soil resources

Some examples of expert systems designed for use in natural resource same each take been listed in a review by Rauscher (1997).

We have developed a small expect system that is designed to diagnose situations in the humid tropics where soil acidity is likely to limit trop production (Tropicals, 1988). This system is based on four modules: soil database, crop requirements, soil/trop management, and economic evaluation. The coil database is, perhaps of most interest to this group.

the soal detabase is comparred of the laboratory data from about 270 pedans from numerous areas in the tropics that have been sampled and analyzed

by the tincolm. Nebraska laboratory. Only selected veriables from the main database have been retained in our 'minimum dataset'. The 'minimum dataset' contains the taxonomy of the soil together with water pH, exchangeable Ca. Mg, 4. Na. and Ai. bull density, and other fertility measurements if present. These data are used to match the soil characteristics to the crop requirements and consequently determine the amount of lime needed to reduce the acidity in excessively acid soils. Because expert systems permit representation of approximate knowledge me are able to suggest that the selected crop may not be appropriate for the soil conditions or that the chosen management options are not appropriate for the soil/crop combination. For example, crops that are known to be sensitive to soil acidity are not recommended on soils of high Al saturation and low pH. Nany rules provide comment and suggestions concerning the appropriateness of the management of the soil and crop combinations.

Several rules determine whether the soils data are consistent with our espectations for pH and amount of Al. The system derives comments from Soil landsomy (SCS, 1975) -- for example, we caution anyone using acid sulfate soils to not try to drain them. Other comments warn of problems using soils with fragipens, of difficulties using soils that are poorly drained, etc. Comments are either 'notes' or 'cautions'. 'Notes' are additional information that might be helpful in understanding the recommendation. 'Cautions' are direct warnings that something may be wrong, either with the data cutered, the crop selected, the management options chosen, or the profitability of the proposed farming system.

while the system points out particular limitations with the user's choice of crop, management, and economic options for a particular soil; it also points out. If the user so chooses, why the limitations were mentioned and the reference for the information. In this way, the inexperienced user of the expert system can pradually acquire the knowledge of expert system while using the system to generate high quality recommendations.

We have also developed a prototype expert system that we call a fsoil data filter: that is designed to aid those with large databases of SCS. lateratory data-metro the ACLINE format. This data filter is designed to check large soil databases for various types of file integrity -- whether the data fall within reasonably limits, whether horizons are missing or overlap, and whether several key variables are consistent with each other. For example, we check for success in the dispersion of the clay, if the clay is not successfully dispersed then ratios based on 100 g clay are recalculated using the 15 har water content. The program permits the user to scan the istoratory data in standard SCS laboratory data output format at any point and especially after the list of printed comments on peopo have been made. Those pedana with comments indicating some inconsistency can then be reviewed by a soil scientist to determine the cause of the inconsistency. We envision such programs being used to screen new sets of data prior to their being accorpted into a validated worl database for use by crop simulation models, expert systems, geographical information systems or other data-intensive computer systems. The soli data filter serves as a type of 'spelling checker' to catch obvious ecrors and mistakes in the data.

As more and more non-soil scientists use soil data they need a means to determine whether the data are consistent and accurate. This system is an example of an expert system written in a procedural language (PASCAL) but whose main value is the laculedge it contains rather than the computation that it does.

### Possible expert systems for soil resource management.

Because expect systems are designed to replicate burnan expect diagnosis and recommendation, they hold provise, it out view, to aid in the dissemination of soil resource management knowledge to decision-makers. Several examples of soil resource management include the following:

### Universal Soil Loss Equation computations:

inguificient data: Notice the USLE equation is mathematically simple, there are many situations, especially in the tropics, where it cannot be applied because critical data are not available. Then data are not available there often are approximations that can be made (El-Swaify et al., 1783). These approximations, however, require considerable knowledge of both the encirc process and of each trop, and climate behavior. In addition, expendice is needed to from if the approximation is sufficiently close to be useful

Inclusion of teamer preferences: Many of the management options suggested by the PSLE meed to be conditioned by the farmer preferences, recommic conditions, and other factors of the farming system whose ernsion states is bring evaluated. Through the expert system structure, influence of farmer preference can be bested as see the effects of economic factors and other conditions such as land tenancy-make these factors have been studied and the associated runes have been determined. The inclusion of these factors points out the capacity of expert systems to bronder the base of limitedge applied in a decision.

By tabulating the conditions and information needed to estimate soil loss, in a 'transparent' computer system, it is possible for farmers to evaluate their own alternatives for notential soil loss. Soil loss estimates for a particular situation can be estimated rather than having to compare values in a pre-calculated table which councilises all the alternatives possible in a computer based system. If the farmer could use the rules to estimate soil loss of his current cropping system or a modification of it he is once likely to find a system that meets his requirements and yet is conservation-offective. The regulatory role can still be exercised by having the farmer demonstrate that his selection of practices is consistent with predictions at or lower than the specified soil loss tolerance.

Recent resource by Smith (1988) indicates that farmers already use computer software to examine various alternatives available to them.

### Links with GIS for resource management

beographical Information Systems (GIS) is a relatively new technology permitting the analysis and display of spatially referenced data (Burrough, 1986). GIS systems permit the display and regional analysis of soil information with a facility becetofore difficult if possible.

GIS systems offer unique analytical capability of working with regional data represented in maps. This analytical capability needs to be coupled with a model in order to be used in supporting decisions. A further enhancement of GIS capability could be made by limiting the GIS with boowledgebases that could answer queries about land use options. Without such linkages with specific information about soils, hydrology, economics, and sociology a GIS system remains a work powerful tool with nothing to do. By limiting GIS with various knowledgebases, persons can involve disciplinary expertise to solve problems on to problem to behavior based on knowledge in addition to that of the GIS user.

The expert system could also be of assistance in stepping through the data requirements, or finding ways to measure the factors, or inferring data from existing information or using alternative methods.

Another application of expert system rules in GIS systems would be in detection of errors in the database, inconsistent results, and noting unworkable alternatives that the GIS user may not be aware of. With judicious selection of such rules to capture common mistakes a GIS system could be used by less experienced persons to perform the complex tasks through step-through procedures prompted by the expert system.

We also envision expert systems as providing the explanation and interpretation of maps and map classes generated by the GIS system. Opportunities exist for using the 'transparency' of expert systems to provide explanation of the significant GIS output of to provide qualification to the interpretation of GIS displays. Such suggestions might point out weaknessed/strengths in the data and suggest variables to change and ceron to order to determine the sensitivity of the results to the input variables. We expect that the evolution of both expert system technology mespecially the greater future role of simulation in expert systems—and of GIS technology will lead to greater complementary in new software.

We have explored the use of a GIS for developing regional recommendations for ameliorating soil acidity (Faulson, 1988). This exercise pointed out that the utility of the expert system could be substantially enhanced by including the regional variation in the recommendation respectably the economic consequences of distance and transportation costs. In the study case, profitability of various land use options was highly influenced by proximity to markets, which was nicely displayed with GIS functions and graphics.

### Literature Cited

- Harrough, P.A. 1986. Principles of Geographical Information Systems for Land-Resources Assessment. Clarecton Press, Oxford.
- FI-Swaify, S.A., S. Arsyad, and F. Kristnarajab. 1983. Soil
  Eroszon by Water. IN R. A. Carpenter. Natural Systems for
  Development: What planners need to know. MacMillian Publishing Co.,
  New York.
- Green, R. E., K. L. Loaque, and R. S. Yost. 1988. Assessment of pesticide leaching using soil survey and taxonomy. Paper presented at the International Interactive Workshop on Soil Resources: Their inventory, analysis, and interpretation for use in the 1990's. Minneapolis, Minneapolis, March 28-24, 1988.
- McCracten, R. J., and R.B. Cate. 1986. Antificial Intelligence, tognitive science, and measurement theory applied in soil classification. Soil Sci. Soc. Am. J. 80:557-561.
- Rauschor, H.M. 1987. Expert Systems for Natural Resource Management Paper presented at the FORS 1987 Annual Meeting, Syracuse, N.Y.
- Smith, D.R. 1988. Sources and uses of information and their implication for the acceptance of Encwledge-based decision support systems in am iculture. Unpublished Ph.D. Dissertation. Fundue University.

- Tropecile Project, 1989. ACIDs: An expert eystem for managing soil acidity in the tropecs. Tropecile Project. University of Hawaii.
- Unitable, A. Dale, E.J. Nombe, and F. R. Foster, 1988. ADAM: An adaptive assembler for eadels.
- Yost: P.S. and R.L. For. 1981. Partitioning variation in soil chemical properties of some Endepts using Soil Taxonoov. Soil Sci. Soc. Am. J. 45:373-377.

(notes from ddy):

I just finished reading throughers the paper. It seems to be a pretty good start. I had only minor ed, changes, which I we sore you will catch when you proof. On R. R, I would suggest that AI research began in the late S0's (I think LISP was written in S0) so has been around for almost S0 years now.

On P. 3. No. 1. Research use of ES is a little touchy with some people who regard this as an "application" of AI research, an argument you have no doubt been thru a time or two. Maybe there should be a distinction between actual development of an ES, and the use of an ES to further research goals. ES, as a tool, can be used alone or in combination with other tools to accelerate and improve research. For anstance, Piecos (or was it Jimmy, or both) Jones developed an FS using a nechanical systems specialist that rould be used by plant researchers to simplify the setup and adjustment of the environmental control system in a greenhouse (something they knew little about anyway) and let the cossections concentrate on their research. There are combinations of ES with simulations which direct and control the simulation, evaluate output and modify input for the pest simulation rua (Jimmy Johns has an article on this, which I have), I believe Dale Whittaler's paper uses on ES to assemble a model to use to sludy vacious soil emosion problems. A similar ES is needed for designing experiments and analyzing data, the I have not beard of such an ES boing developed. The data filte: which you describe later in the paper is another erample of using an ES to improve conventional research.

On P. 6. under the USLE. I think maybe there is infor in Dale Whittaker's paper that would fit have. It has been over a year since I read a Graft of his paper, but sooms like his main interest was the USCE.

On F. 7. under links with 61S, I have a fairly good hiblic put together back at Purdue in this area, and a couple pages written down. It is on IMIX so I will email it open my return. There are 3-4 sepecially good references that I found. I wrote this last Dot., so believe the lit. roview is fairly current. As I recall, the major potential armas that I identified were in areas such as blunder detection, identification of features. Labeling of features, and us a front end to make a large complex BIS system available to sovice users (administrators and people in unrelated fields who people acress to GIS, but don't want to know about the details) and amouthing interfaces to application programs. I remember thinking about using planning ES interfaced to OIS (things like planning routes for emergency vehicles on the fly, based on a GIS of the area and changing, up to date info on traffir flow coming in from installed sonsors), but don't remember whether I put that in or not. Thus last is just an extension of trip planning ES based on 615 and a correct report on road and weather conditions, which should be available for the family can one of these days.

I'm afraid all my references are now in transit, but I can send a few good references to you in addition to the GIS stuff, upon my return. I thought about logging outs the Pardue computer and downloading it,

but have never figured out how to do that with a credit card, and direct dislanding long distance at this stage in my stay will conficate my local billing acrangement with my father-rankas.

John I) has a deaft of as rate of Schep. (or the book that I worked on this sem, which lists all of the eaf, which I will send you, except for the GIS stuff.

lartly. I have been thinking about the papava project the last couple of days, and wanted to pass along by by two peats worth. It still reces to be that the final section should be coded using a compared at ES shells regardless of whose you use to develop at. distriterrance is forther important concern, for progress like AcidA and the papaya ES, which are essentially communical software. I have 16 applications extension progress which have been released for any in the process of being released; since 1976, and maintenance is a PEGL pain. Some of those problems are in subject matter areas that I have not worked in for 5-6 years (nor do 1 have any interest in getting back up to spend in those a cash, but still I must maintain them. My point is, I guess, that fixing problems with the subject matter is bad example. but furing legic problems, even in a well doc, prolog program is likely to be such worse. Furthermore, I would expect Steven will be off on now adventures and no core interest in maintaining the papaya ES than I take to fixing problems in my old programs. I believe this is a strong acquateri for producing the final version with a shell, where virtually all polential changes are in the knowledge base as opposed to the program.

Thanks again for making as stay in HI so productive, stimulating, and pleasant. I have written two book chapters, two extension publications. Iesu ned SutoLad and MordFerfect, and read several books and articles, and thoroughly enjoyed my discussions with your John and Steven. I host forward to continuous one professional relationship in the future.

Water Erosion Productivity Project(WEPP) Modeling

### T. M. Sobecki, Soil Scientest, NSSL

Since the topic to be discussed is modeling, it would be good to review some overall concepts of models and modeling in the sense we will be discussing them.

First of all, what is a model? As with most terms, there are several definitions. The definition we choose depends on what we wish to do with a model. Two definitions In a qualitative sense model is a pertain to our usage. description or analogy used to help visualize something that cannot be directly observable. While the effects of soil erosion are all too often easily observable, the actual process often takes place in such a gradual manner that it may be difficult to study or characterize. We might then use a model to help us visualize the erosion process. We are making no statements yet as to what form this model might take.

A second, more specific definition of model is also applicable. A model is a system of postulates, data, and inferences presented as a mathematical description of an entity or state of affairs. This type of model applied to our discussion carries with it the implication of quantification of the erosion process. By quantifying the process, we can be more precise in our observation and description of the phenomena, can make use of numerical and automated computational techniques, and be more specific(though maybe not more accurate) in our predictions about the process.

This definition of model is built around three other terms we need to have a good understanding of: postulates, data, and inferences. First, postulates. A postulate, in this case, is merely an hypothesis treated as an essential presupposition of a train of reasoning. We can then regard the postulate(s) underlying the model as a theory(an hypothesis assumed for argument or investigation). merely something used as a basis for calulation or Inferences are conclusions derived from facts or measuring. premises(postulates). Manipulating data in light of our postulates, we attempt to derive conclusions(make inferences) regarding a process understudy(the state of affairs were interested in). This is the type of model we will be discussing when we talk about WEPP.

To clarify all this talk about models we might look at a simple classification of models. A real system can be modelled by either material models(physical models) or formal models(mathematical models). This information is taken in part from Rosenbluth and Wiener(1945) and Woolhiser and Brakensiek(1982). Physical models can be split into iconic(physically resembling) models and analog(functionally resembling) models. Mathematical models(the kind we will be dealing with) consist of empirical and theoretical models.

Empirical implies a model based on experience or observation alone without regard to theory. Theoretical models, on the other hand, are based on theory(postulates) and incorporate empirical data in the form of parameters or constants.

Finally, "Why do we construct a model?" Hopefully we gain fuller insight into the process of interest after we have modelled it. Models can serve two basic functions. That of prediction, and that of testing. In prediction, we focus on the output of the particular model. What is the result of the action of the process in a specific situation. This would make use of models constructed from a deductive approach. They would use known or assumed relationships to infer specific conclusions. The other utility of models arises in testing the hypotheses(postulates) upon which the model is based. Such models might be constructed inductively, a process more akin to the traditional scientific method. One would reason from observations of the natural world to formulate a universally applicable hypothesis for subsequent testing.

In discussing WEPP, we are concerned with the predictive uses of models. WEPP

### The WEPP Model

What is WEPP? An anacronym for Water Erosion Prediction Project. The objective of WEPP is to develop new water erosion prediction methodology, in the form of a theoretical model, that will replace the USLE for conservation planning activities. Accordingly, the target group for WEPP is current USLE users in general and SCS field personnel in particular. Also included are the USDA-FS and USDI-BLM.

A measure of the success of WEPP will be whether its model becomes the "method of choice" over the USLE for erosion prediction and conservation planning(Foster and Lane, 1987). The USLE is a "lumped" model. Sheet and rill erosion are lumped together into one output value, A(T/ac/yr) and all the input factor interactions are also lumped into one output, again A. TheUSLE does not recognize spatial variability in any of its input factors, it is a static model(time is not an independent variable in the model), it is based on empirical relationships, and predicts only erosion. USLE is a useful model, but it has come of age.

The WEPP model, on the other hand, is a **theoritical** model that is process oriented. It treats erosion, transport, and deposition, is modular in design(erosion factors are treated seperately, is dynamic in the sense that time is also an independent variable in the model, and it considers spatial variability in the soil factors affecting erosion, It will also be of structured design. Code will be transportable and documentation provided Erosion processes and WEPP

The WEPP model is process-oriented. Process in a general sense refers to a natural phenomena marked by successive changes that tend toward a particular result.

The word "process" in a restricted sense can be thought of as a noun that defines dynamic actions involving application of forces over gradients(Embleton and Thornes, 1979). As erosion in itself is a dynamic process involving forces over gradients it seems only logical that it might be understood and predicted through a modelling of those very process. The WEPP model stands in contrast to the USLE. The USLE is an empirically based formal model. The WEPP model is a theoretical formal model, based on an understanding of the erosion process.

Three major process are involved in water erosion. These are soil particle detatchment, particle transport, and particle deposition. The agents that drive these processes are raindrop impact and surface water flow. Interaction of the erosion agents with the soil results in sheet erosion, rill and interrill erosion, gulley and stream channel erosion. Sheet, rill and interrill, and ephemeral gulley erosion are addressed by WEPP.

To understand how the WEPP model functions, one must have an appreciation for the factors that affect the erosion process. These factors include: 1) hydrology, 2) topography, 3) soil erodibility, 4) soil transportability, 5) cover, 6) incorporated residues, 7) past land use, 8) tillage, and 9) roughness. The question then becomes how does the WEPP model take into account these factors in modelling the erosion process?

The WEPP model is actually a series of models interrelated to one another. Each model within the overall WEPP model corresponds to one or several of the erosion factors. There is a hydrologic model that drives the basic erosion model, calculating hydrological inputs(mainly runoff). It also contains a climate generator. In terms of the land use factors(cover, use, and management), there is a plant growth and a root and residue decomposition module. This module contains a plant growth simulation model and a model which simulates the decompostion of crop residues and roots. A tillage model handles soil-disturbing activities such as implement use, initializing soil properties after tillage.

Also driving the erosion model is a sediment transport and deposition model, and a snowmelt and frozen soil model.

### WEPP requirements

Looking at the WEPP model requirements formulated by the cooperating agencies, including potential users, we can get a better idea of what the WEPP procedure is designed to accomplish.

Size of the area to be handled by the model is "field"size(about 640 acres maximum). It should contain no
permanent gulleys but ephemeral gulleys are allowed. output
of the model is a function of the particular version being
applied, but in general will include erosion and

deposition(sheet and rill, and concentrated flow erosion),
sediment yield, and sediment character(fineness). The model
will predict the impact of the erosion factors climate,
soil, topography and landuse on the above output values.

Output values will be able to be computed on a number of time bases, from long term average annual rates(like the USLE), through frequency distrubutions by event, single design storms, or even continuous simulation. Climatic data input will be generated by a weather generator model, or can be taken from records or design storms. The WEPP procedure must apply to so called "key" soils. The key soils are those having a range in properties thought to effect soil erodibility. The model must handle eroded and uneroded soil phases. Soil input into the WEPP model will be in the form of a prerecorded database, transparent to the user. The mapping unit will be specified to input the appropriate soil properties into the model for a given situation. This data base is envisioned as being modifiable, and thus could be customized by the user over time.

A variety of land uses are being accomodated for future

A variety of land uses are being accomodated for future development, but cropland, rangeland, and disturbed forestland are being addressed in the current project. In addition up to ten combiniations of land use patterns can be

accomodated in a given field.

Topography will be handled by having three diffenent versions of the WEPP model. These consist of the profile, watershed, and grid versions. In the profile version a representative landscape profile is selected by the user. Input data consists of slope length, average steepness, inflection point, and curvature, or short slope steepness segments along the profile. Output will consist of net erosion or deposition, rill erosion or deposition, interill erosion, eroded or depositied sediment fineness, and sediment load and fineness. Representative profiles will be stored so weighted averages for the field can be compiled. Erosion will be expressed as sediment yield/unit slope length, and erosional rates for different parts of the landscape will be able to be computed.

The watershed version will output the same information as the profile version but in addition will present data on concentrated flow erosion. Additional input data required will be channel crossection and profile data, outlet information, and drainage areas. The grid version will allow coverage of entire areas of various shapes but output the same data as the watershed version. Input data such as slope steepness and direction, channel properties, etc. will be taken for each of the grid squares.

One of the advantages of WEPP is that it will allow soil properties influencng erosion (erodibility, infiltration, etc.) to vary with the soil mapping unit. This suggests that our mapping unit variabilities could be an important unknown factor when applyinbg this model, as only variability at or above that of the mapping unit will

be detected by the model. Knowledge of location and extent of inclusions could become critical in such a situation.

WEPP model implementation

The development of WEPP follows the typical sequence of any theoretical model development. The process(es) to be modelled are conceptualized and described, translated into mathematical experessions(often a difficult step), then algorithms devised and coded(computer programming). A crucial final stage is testing and validation of the model(i. e. does the model give us "real world" answers).

In many cases the validity of the model is a function of the parameters(constants) put into it for a given situation. Remember, most theoretical models also consist of some empirical data and relationships in addition to the postulates on which the model is based. Many model parameters fit the definition of empirical data(unlike the basic postulates upon which the model may be based). The empirical parameters input real-world coefficients into the model equations.

A portion of the WEPP project has involved collecting soil properties related to erodibility, infiltration, and soil transportability. This involved rainfall simulator studies and soil characterization of the so-called "key" soils around which WEPP is designed. Part of the purpose of these soil studies is to generate parameters to drive the WEPP model and to assist in its validation. An initial version of the model is to be completed and ready for testing in 1989. Provisions are currently being made by SCS to accomodate the model, which is in reality a family of computer programs, in the ADP system.

### REFERENCES

- Embleton, C., and J. Thornes. 1979. Process Geomorphology. John Wiley and Sons, New York. Foster, G. R., and L. J. lane. 1987. User Requirements.
- Foster, G. R., and L. J. lane. 1987. User Requirements. USDA-Water Erosion Prediction Project(WEPP). NSERL Rpt. No. 1. USDA-ARS.
- Foster, G. R. 1982. Modeling the erosion process. In Hydrologic Modeling of Small Watersheds. Haan, C. T., H. P. Johnson, and D. L. Brakensiek, eds. Am. Soc. Ag. Eng., St. Joseph, MI.
- Iseminger, G. 1968. An Introduction to Deductive Logic.
  Appleton-Century-Crofts, New York.
- Rescher, N. 1980. Induction. An essay on the justification of inductive reasoning. Univ. of Pittsburgh Press, Pittsburgh, PA.
- Rosenbluth, A., and N. Wiener. 1945. The role of models in science. Phil. Sci. 12(1):316-321.

# Business Meeting

# 1. 1990 Conference Host

Fairbanks, Alaska was selected as the next conference host state. Dr. Chien-Lu Ping will chair; Joe Moore will cc-chair; Earl Alexander will serve as secretary. The conference is scheduled to be held in June.

# 2. Soil Taxonomy

Bob Engel, Soil Scientist, Washington and Bandy Southard, University of California, Berkeley were nominated to the Soil Taxonomy committee.

# 3. Soil Interpretations Committee

Bob Meurisse will chair. Elected were Jerry Simonson, Jim Mclaughlin and Dave Smith.

Thanks to this years steering committee - Ike, Harry, Bob and Mon.

### WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE

# PURPOSE, POLICY AND PROCEDURES

# I. Purpose of the Conference

The purpose of the Western Regional Cooperative Soil Survey Conference is to bring together Western States representatives of the National Cooperative Soil Survey for discussion of technical and scientific questions. Through the actions of committees and conference discussions, experience is summarized and clarified for the benefit of all; new areas explores; procedures are synthesized; and ideas are exchanged and disseminated. The conference also functions as a clearing house for recommendations and proposals received from individual members and State conferences for transmittal to the National Cooperative Soil Survey Conference.

# II. Membership

# A. Permanent Membership

Permanent members of the conference include those individuals or positions listed on the attached Permanent Membership List. Individuals or organizations may be added to the list as deemed necessary by the current Steering Committee. The list will include agency, name (where known) title, address and phone number.

# B. Associate Membership

Invitations **may** be extended to a number of other individuals to participate in a specific conference or conferences. Any soil scientist, technical specialist, or other individual of any local, state or federal agency or interest group whose participation will benefit particular objectives or projects of the conference may be invited to participate. Any permanent member of the conference may invite one additional participant. If a permanent member wishes to invite more than one guest (or associate member) the request should be cleared through the Chairman or Co-Chairman of the conference, or the Chairman of the Steering Committee. Names of all associate members of a specific conference should be sent to the conference chairman.

# III. Officers

# A. Chairman, Co-chairman and Secretary

A chairman, co-chairman and secretary of the conference are elected to serve for two-year terms. Elections **are** held during the biennial business meeting. Election of officers follows the selection of a place for the next meeting, and **will** be from the state hosting that meeting. Officers rotate among the agencies. This is, the chairman-elect must represent a different agency than the past chairman. Similarly, the co-chairman and secretary must be of different agencies than their predecessors.

Responsibilities of the chairman include the following (specific tasks maybe delegated to the co-chairman):

- 1. Planning and management of the biennial conference
- 2. Function as a member of the steering committee
- 3. Preside at the conference business meeting
- 4. Issue announcements and invitations to the conference
- 5. Organize the program of the conference, select presiding chairman for the various sections, write the program, and have copies of the program prepared and distributed.
- 6. Make necessary arrangements for lodging accommodations for conference members, for food functions, if any, for meeting rooms (including committee rooms), for a field trip, and for local transport for other official functions.
  - 7. Duplicate and distribute the Proceedings of the Conference.
  - 8. Provide for appropriate publicity for the conference.
  - 9. Arrange for guest speakers for the conference.
  - 10. Preside over the business meeting of the conference.

Responsibilities of the co-chairman include the following:

- 1. Function as a member of the steering committee.
- 2. Act for the chairman in the chairman's absence or disability.
- 3. Assist the chairman in carrying out the chairman's responsibilities, and perform duties as assigned by the chairman.

Responsibilities of the Secretary include the following:

- 1. Maintain minutes of the conference business meetings and other conference meetings as assigned by the chairman.
- 2. Obtain copies of all committee reports and papers presented at the conference, and see that copies are made available to all conference members.
- 3. Compile the conference proceedings and assist the chairman In the duplication and distribution of the proceedings.

# B. Steering Committee

A Steering Committee will be selected to assist in the planning and management of the biennial conference. The Steering Committee consists of:

Principal Soil Correlator, Western States (permanent chairman)

The conference chairman

The conference co-chairman

The conference secretary

The conference past chairman

All other Permanent Members from the Host State

# Responsibilities of the Steering Committee:

- 1. Formulate committee charges as recommended by the conference.
- 2. Select committee chairman and committee members as recommended by the conference.
- 3. Review conference activities and develop an executive summary of conference recommendations.
- 4. Send applicable conference recommendations to the Steering Committee chairman of the National Cooperative Soil Survey Conference.
- 5. Send applicable conference recommendations to the soil survey leaders of appropriate agencies for **consideration** and **possible** implementation.

### C. Advisors

Advisors to the conference are the State Conservationist of the host state, or as selected by the conference, and the Experiment Station Director from the host state, or as selected by the conference. A Forest Service Regional Forester and BLM State Director may also serve as advisors as requested by the conference.

# D. Committee Chairman

**Each** conference committee **has** a chairman. The chairman are either selected by the conference or are appointed by the Steering Committee.

# IV. Neetings

# A. Time of Meetings

The conference convenes every two years, in even numbered years. It is held the second full week in February, unless a different date is agreed upon by a majority of conference members.

B. The conference will be held on a rotational basis throughout the region. Any permanent member may invite the conference to meet in their state. The conference members at their biennial business meeting will note on which invitation to accept, or where to hold the meeting if no invitations are received. If no state offers to host the conference, and the conference does not vote to meet in a specific site the conference

will be held **in** San Diego, California, and the conference members will elect a state to **serve** as host State to perform the functions discussed in these procedures.

### V. Committees

The conference will have both permanent standing committees and special committees.

- A. Most of the work of the conference is accomplished by duly constituted official committees.
- B. Each committee has a chairman. A secretary, or recorder, may be elected by the committee or appointed by the chairmans, if necessary. Committee chairmans are selected by the Steering Committee or are elected by the conference.
- C. The kinds of committees and their charges are determined by the Steering Committee, based on the recommendations of the conference. Committee members are appointed by the Steering Committee after first determining the Interests of conference members. The Steering Committee will assure that there is a balance among **states** and among agencies or each committee that is no one state or agency will dominate any single committee.
- D. Each committee **shall** make an official report at the designated time at each biennial conference. Committee reports **shall** be duplicated and copies distributed as follows:
- 1. One copy to each permanent member (whether present or not) and to each participant in the conference.
- 2. One final copy to the Conference Secretary for inclusion in the conference proceedings. This copy will include all revisions approved by the conference.

NOTE: Committee Chairmen are responsible **for** prompt submission of their reports to the Chairman of the Steering Committee who **will** duplicate and distribute the reports. This should be done prior to the holding of the conference.

- E. Most of the committee work will be, of necessity, conducted by correspondence between biennial conferences. Committee chairmen are. responsible for Initiating and carrying out this work.
- F. Permanent Standing Committees may be established by the conference. These committees will report to each biennial conference until such tine as they are disbsnded. Permanent Standing Committees are:

Western Regional Soil Taxonomy Committee

G. Conference Proceedings

A proceedings will be developed for each biennial conference. It will be compiled by the conference secretary and reproduced and distributed by the conference chairman, with assistance from the Steering Committee Chairman.

Sufficient copies will be reproduced for distribution as follows:

One copy for each permanent member, whether in attendance or not.

**One copy** for each associate member in attendance at the conference.

Twenty copies for the **Chairman** of the Steering **Committee** of the National Cooperative Soil Survey Conference.

Twenty-five copies for the Steering Committee Chairman of the other three regional conferences.

### VI. Amendments

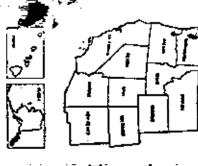
Any part of this statement of purposes, policy, and procedures may be amended at any time by simple majority vote of the conference members present at a conference, or by a mail vote of the permanent members.

# NATIONAL COOPERATIVE SOIL SURVEY

# Western Regional Conference Proceedings

# Portland, Oregon June 23-27, 1986

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# EY CONFERENCE

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The Portland Inn Portland. Oregon

June 23-26. 1986

# AGENDA

Monday, June 23	R. T. Meurisse, Moderator
9:30 - 1:00	Registration
1:00 - 1:15	Opening remarks and announcements
1:15 - 1:30	Welcome address - Jack Kanalz, State Conservationist, Oregon
1:30 - 1:45	Welcome address - Dean Brisky, Dean, College of Agriculture
1:45 - 2:55	Agency perspectives on the Future of NCSS (15 minutes each for presentation and discussion)
	Bill Reybold - SCS, Washington, D.C.  Jim Engibous - Experiment Station Rep  Washington State University  Jim Stone - BLM, Washington. D.C.  Pete Avers - Forest Service, Washington, D.C.
<b>2:55</b> - 3:00	Give charges to committees
3:00 - 3:30	Break

3:30 - 5:00

# Conference Committees

Remote Sensing - Tom Calhoun, Chairman

Data Base Systems - Chuck **Goudey**, Chairman

Review of NCSS Program - Jim Cerley, Chairman

Standing Committees

Taxonomy - Dick Kover, Chairman

Application of Lab. Methods - Bill Allerdise,
Chairman

Interpretations - Bob Meurisse, Chairman

Research Priorities - Dave Hendricks. Univ. of
Arizona. Chairman

# Tuesday, June 24

Byron Thomas, Moderator

8:00 - 9:30

Food Security Act of 1985 - Discussion of **Conservation title,** sod buster end swamp buster **provisions** 

Overview and impact o" NCSS - Bill Reybold, Soils Division. SCS Implementation by states -Don Thompson - State Director, ASCS Jack Kanalz, State Conservationist. SCS

9:30 - 10:00

Break

10:00 - 12:00

Agency Meetings - Each agency use this opportunity to meet with their members to discuss agency issues.

12:00 - 1:00

Lunch

1:00 - 1:15

Report of National work Conference - Status and Progress - (R. )Kover

1:15 - 2:15

2:15 - 2:30

2:30 - 3:00

3:00 - 5:00

# Wednesday, June 25

Field Trip - All day

Soils. Geomorphology, Vegetation, and Land Use in Northern Willamette Valley and Mt. Hood Area  $\,$ 

Thursday. June 26	Jerry <b>Latshaw</b> , Moderator
8:00 - 9:00	Task Force Reports (1/2 hour each)
	Verification of Soil Surveys - Randy Southard Future Role of NCSS Soil Scientist - Gordon Huntington
9:00 - 10:30	Standing Committee Reports (15 minutes each)
	Taxonomy ~ R. Kover Interpretations ~ R. Meurisse Break' Research Priorities ~ D. Hendricks Application of Lab. Methods ~ B. Allerdise
10:30 - 2:00	Conference Committee Reports and Discussion (1 hour break for lunch)
2:00 - 3:00	Business Meeting
3:00	Adjourn
Friday, June 27	Jerry <b>Simonson</b> - Moderator
8:00 ~ 3:30	Workshop - Soil <b>Climate</b> (Moisture and Temperature)

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### REPORT FROM THE COMMITTEE ON RMOTE SENSING

The charges presented to the committee on remote sensing were to:

- 1) Define "Remote Sensing" as it applied to soil survey.
- 2) Using this definition. develop a paper on current state-of-the-art in remote sensing as related to soil surveys.
- 3) Identify those remote sensing projects and materials that **are** both helpful and operational at the field **soil** mapping level. These **would** be already proven, cost-effective projects and materials.

To accomplish these tasks, the committee first decided on a definition for remote sensing as it applies to soil survey. That definition is as follows: THE ACQUISITION, STORAGE, ANU USE OF REFLECTED OR EMITTED RADIATION MEASURED BY GROUND, AIRBORNE. OR SPACEBORNE SENSORS TO IDENTIFY AND QUANTIFY LAND SURFACE, VEGETATIVE, AND OR SUBSURFACE SOIL CHARACTERISTICS THAT AID IN CHARACTERIZING SOIL BODIES AND IN DELINEATING THE BOUNDARIES BETWEEN MAPPING UNITS.

The use of this definition provided the committee a great deal of latitude in dealing with the second charge. The definition not only covers the traditional use of remotely sensed data for soil mapping or the placement of boundaries identifying map units, but also characterization of the soils within the boundaries as to percent of components and physical and chemical properties of the individual soils. In addition, the storage and acquisition of the data is covered.

To determine the current state-of-the-art, the committee members were polled on use or knowledge of uses of remotely sensed data, and each state Soil Conservation Service office was asked to provide information on any applications they were aware of. Approximately 26 different projects were identified. Summaries of these projects are included as Appendix 1. A review of the papers shows that remote sensing is being used in soil survey to: 1) Accelerate the rate of mapping; 2) Improve the reliability of map unit composition evaluations; 3) Improve accuracy of soil pedon descriptions; 4) Collect on-site data to improve soil classification information; 5) Publicize use of soil survey information; and 6) Augment the production of map products using existing information. This is acutally an oversimplification since most of the listed projects were designed to achieve several of the listed objectives.

The technology being used to gather the basic resource data or imagery is rather limited. ERTS or LANDSAT, NHAP, Ground Penetration Radar, Side Looking Airborne Radar. Heat Capacity Mapping Mission Satellite, Digital Elevation Model data. and specific one purpose imagery such as low elevation color or black and white aerial photography contracted for a specific project are the imagery sources. The types of products being

used from these sources are more extensive. Emphasis is still being placed on Color Infrared Imagery. The majority of the projects listed are using CIR imagery and either varying the scale or are using some type of imagery analysis program to assist in identifying map unit boundaries. Imagery is being obtained from several sources such as NHAP, ERTS, or special. contract. Low altitude, 35mm large scale (1:1200-1:600) black and white and color photography is being used in several projects. The additional detail in the imagery allows for better quantification of map unit components. The small scale photography (1:24000 and smaller) is especially useful for identification of landforms or landform segments that define map units but in most cases is not the best for quantifying map unit components. An example of this is using CIR ERTS photocomposites at a scale of 1:250000 to develop the state general soil map data base. A listing of the remote sensing products and techniques currently being used in soil survey is given in Appendix 2.

Landsat imagery has been used in several projects. Most of these projects involve an evaluation of Landsat imagery rather than a cost effective proven application. A key to using the Landsat imagery is in the stratification of the data. In Idaho, Arizona, and Nevada, Landsat imagery stratified by landform and parent material has been useful in providing the mapper with a different perspective when combined with traditional field mapping techniques. Such items as changes in homogeneous parent material, in plant communities, in major land uses, or in land forms can be detected. Reports indicate the Landsat imagery is best used in combination with topographic maps, slope maps, aspect maps. etc. to provide supplementary information when placing map unit boundaries on field sheets. Again the key seems to be in stratifying the Lsndsat image to fit the area itis being used in. In one Nevada test, Landsat was not helpful when stratified for soil surface color. A more useful tool would have been stratification for plant community differences.

Another product being used in several areas is Digital Elevation Model data or digital terrain data. This is topographic data that can be used to generate terrain products such as slope maps and aspect maps. Tests in Oregon and Nevada have shown these products to be valuable tools in projecting map unit boundaries into remote, inaccessible areas where adequate ground truth has been obtained, and for developing pre-maps of areas to assist in maximizing field time in questionable locations. They are also useful in areas where dense vegetation restricts the mappers ability to see the lendform. These products, as with Landsat MSS data, were found to be useful when used in combination with field sheets and topographic maps. They provide more information to the mapper for making line placement decisions.

Side Looking Airborne Radar (SLAR) provides imagery when traditional photographic imagery is unavailable or unsuitable for soils mapping. The radar can penetrate most cloud cover and vegetation to provide imagery where landforms and geologic features are enhanced. This imagery is most useful when used in conjunction with other products such as topographic quadrangles, and Color Infrared imagery. It is available through USGS for most of the NE U.S.. Central California, and the Aleutian chain of Alaska. No trials of the imagery for soil survey were reported.

Remotely sensed data is also being used to improve or augment soil classification. Soil temperatures **are** being inferred from Satellite Acquired Thermal-Infrared Data through the Heat Capacity Napping **Mission** Satellite. Soil moisture and temperature measurements **are** being monitored using sensors to periodically transmit data to base stations. This is commonly referred to **as** a Popcorn System, or a system similar to SNOTEL technology.

One of the more recent tools for remotely sensing soils data is the Ground Penetrating Radar. This equipment emits a signal which is reflected by materials having different physical and chemical properties. Depths to diagnostic horizons, bedrock, watertable. etc. can be determined and their continuity along a line of transect can be measured from the surface. The reflected waves can be printed in a graphic form or captured on tape for future replay or enhancement. This technology is being used to characterize map unit composition by transecting map unit delineations and determining the percent of different soils along the transect. It is also useful in measuring the variation of soil characteristics for a series. Locating typifying pedons for soil characterization sampling can also be done more accurately.

Imagery enhancement and Video Image Analysis (VIA) are rather new technologies in which video or digital data are analyzed for image density separations. some of which are beyond human capability to see. In a sense, the imagery is intensified and differences that are either not apparent or were beyond the human sight capability are identified, displayed, and quantified. Subtle differences in surface color or relief etc.  $\square$  ey be used to develop maps that can augment field mapping.

Although this paper is to **deal** with current state of the art for applied remote sensing techniques, a brief look at what new technologies are eminent will **serve as** a summary. As each generation of satellites advances, improvements include higher spatial resolution, more spectral bands, and increased radiometric **quantization**.

Recently the European Space Agency launched a new satellite (SPOT) which has a pointable linear array sensor that acquires 8 — bit image data in only three spectral bands, but the spatial resolution is 10 to 20 meters, and it has the capacity for stereoscopic images.

AVHRR (Advanced Very High Resolution Radiometer) is a sensor on the NOAA series of weather satellites. It has a spatial resolution of 1 Km., but its 9 — hour repeated orbit provides an excellent monitoring tool for broad resource needs.

### APPENDIX 1: SUMMARIES OF REMOTE SENSING PROJECTS.

- 1. Color Infrared photography is used in a Coastal Marsh inventory project on 3.4 million acres of marshland in south Louisiana. Marsh salinity changes are traced by changes in vegetative regimes as salt water intrudes in brackish conditions and brackish conditions Intrude the fresh water marshes. The amount of land lost to open water each year can also be calculated utilizing the CIR photography.
- 2. <u>Soil Temperature Investigations Using Satellite Acquired</u>
  Thermal-Infrared Data In Semi-Arid Regions R.L. Day, G.W. Petersen, The Pennsylvania State University. Agronomy Abstracts, 1982 Annual Meetings; Anaheim, California; November 28-December 3, 1982

At The Pennsylvania State University, G.W. Petersen. and R.L. Day made soil temperature investigations using <code>satellite</code> acquired thermal-infrared data in semi-arid regions of southeastern Utah. The data acquired from the Heat Capacity Mapping Mission satellite <code>were</code> used to map mean annual soil temperatures and annual surface temperature <code>amplitudes.</code> Selected (obtained from the <code>HCMM</code> Satellite data) average daily temperature data sets were extrapolated to provide mean annual soil temperature and annual surface temperature amplitude predictions with associated statistics. These predictions were registered to Digital Terrain Elevation data and topographic base maps <code>to</code> evaluate <code>their</code> spatial distributions and relationships to both elevation and aspect.

3. Evaluation Of Landsat Multispectral Scanner and Thematic Mapper Data For The New Jersey Multiresource Inventory. Report on Phase 1 and II Activities. J. Vogel, USDA-SCS. New Jersey, and T. Airola, Cook College Remote Sensing Center, Rutgers University, New Jersey.

SCS and Rutgers University are developing remote sensing methods for mapping and monitoring resources in N.J. Using remote sensing data they plan to reduce the amount of field wcrk, time, and money required to update New Jersey resource information for the National Resource Inventory and to provide timely land cover/land use information for other SCS programs in the state. Landsat Multispectral Scanner data (MSS) and Thematic Mapper data (TM) are being evaluated. Satellite data analysis is being made to delineate land cover classes and to detect changes in land use that have occurred during the past decade.

4. Photography For Order 2 Soil Surveys B. O. Kunze, USDA-SCS. Brookings, South Dakota and G. D. Lemme, South Dakota State University. Brookings, South Dakota

Four types of aerial photos (panchromatic .6-.7um and .5-.7um, black and white infrared .7-.9um, and color infrared .5-.9um) were evaluated for soil survey purposes. Panchromatic .5-.7 and color infrared proved most useful. The photography was evaluated by A soil survey party to determine the type or types of photography most useful in distinguishing soil differences within complex mapping units with a variety of land rover types. Color Infrared (CIR) was preferred for recognizing and identifying tonal differences among soil series within mapped areas with no lend cover. crop residue, and growing small grain. CIR and panchromatic were similar in ease of recognition of tonal differences among soil series within mapping unit complexes where alfalfa or pasture covered the soil surface. The most useful photobese for soil mapping was a combination of CIR and panchromatic since more features could be detected than with any one type of photography.

- 5. In Virginia SCS has had similar experiences and is supplying all Soil Survey parties with Color Infrared and Black 6 White photos at a scale of 1:24000. The stereo-pair technique using this imagery is the best image for evaluating relief. This technique is used to determine dominant soils and in line placement. With ground verification, accurate interpolations can be made for similar parts of the landscape. Each different CIR photo has to be proofed. as the signature doesn't carry from one to the next. The color contrast is so good that the soil scientists can do a better job of first determining and then placing the soils boundary on the black and white field sheet.
- USDA-SCS in Oregon has explored the feasibility of using the digital arc-second DEM (digital elevation model) date from the 1:250000 Medford quad and expanding the data to 1:24000 for the McConville Peak quad. Products received were: North and South aspect maps and mylars with aspect not requested on slopes of less than 12 percent; slope maps and mylars, one blue tone set and one multicolored set with 0-11, 12-35, 36-50, and 51+% slopes; mylar polygon map with 10 acre filter; and a statistical summary of polygons (224 polygons). The vegetative cover of the quad was forest. Aspect and slope maps were chosen since aspect affects productivity and slope affects harvesting. Aspect and the 35. and 50 percent slope breaks are critical for management. was developed combining the slope and aspect  $\square$  ylars. This was placed over the orthophoto quad and the lines were adjusted to coincide with the imagery and topography. Aspect needed adjustment along secondary

drainages. Slope needed adjustments and or additional lines to indicate breaks in slope across ridges, and numerous line refinements were made to coincide with contours. The maps did provide a good perspective of the area in identifying patterns and extent of aspect and slope groups for the formulation of potential map units. The maps could be used in mapping, but time input for line adjustment could not be justified. The statistical summary data is impressive and would be valuable for documenting mapping units in terms of percent slope inclusions, determining elevational range, and acreage extent.

- In Arizona digital image processing of Lsndsat Multispectral Scanning (MSS) data proved to be a complementary tool for mapping soils on rangeland. Digitally processed Landsat data, stratified by landform and parent material proved useful in displaying suites of soils, general soil patterns. geomorphic surfaces, and identifying areas of differing soils. Output products such as color coded spectral class grouping maps, and black and white symbol maps were used in the office as planning and organizing tools. These products provided users with a higher degree of confidence when extrapolating data from one area to another. Comparison of output products with aerial photographic interpretation helped identify major soil patterns and helped reduce the field time commonly spent investigating soil transition zones. time was used more efficiently to locate areas where soil series descriptions, soil transects, and vegetative descriptions could be obtained. The use of Landsat MSS data was cost-effective, saving time and money, as well as enhancing the quality of the soil survey.
- 8. Combining Land-Use Data Acquired From Landsat With Soil Msp Data
  Using An Information System F. C. Westin, T. M. Brandner, M. W. Wehdee;
  PECORA VII Symposium Proceedings; Sioux Falls, South Dakota; Oct.18-21,
  1981.

A South Dakota study indicates the combination of Landsat imagery and small scale soil map data can be used to produce a soil association map. The concept of positioning of agricultural use patterns based on catenal relationships is reinforced by viewing land-use patterns from Lsndsat imagery. Landsat imagery, however, is not suitable by itself for mapping soils. Small scale soil maps (1:1,000,000-1:5,000,000) do not always provide sufficient detail for predicting adapted crops or yields. The combination of a small scale soils map and a land use map into an information system can produce soil association maps with map units characterizing soils and cropland use intensity which are more usable in predicting agricultural uses and productivity.

9. Improved Mapping Unit Delineation Accuracy Using Landsat MSS Spectral Maps W.D. Harrison. M. E.; USDA-SCS. Idaho.

SCS & Purdue Laboratory for Applied Remote Sensing (LARS) tested digital Landsat Multispectral Scanner (MSS) data on a third order soil survey of the Big Desert Area of Idaho. An on-going survey was present. Mapping unit boundary locations were a primary concern. Subtle changes in relief, vegetative patterns and parent materials unique to the area couldn't be seen on the 1:24000 photos used for mapping. and traverses would be needed to determine mapping unit delineations and composition. Landsat data collected Aug. 1978 were used. Data were sampled and clustered using a systematic procedure and representing #2% sample of the area. The resulting classes were merged until spectrally significant classes representing major land features were determined. This resulted in 22 and 19 separable spectral classes for the eastern and western parts, respectively. The resulting maps were designed to overlay corresponding 7.5 minute topoguads. Ad hoc symbols were used to represent each spectral class. Clusters of similar symbols formed patterns characteristic of significant surface features. Lava beds, for example, were separable based on surface roughness and amount of vegetative cover. Field testing showed most maps were useful. map, when used with the corresponding field sheets, presented the soil scientist with a different perspective for viewing surface features. Many features not visible on the field sheets, such as volcanic ash deposits, changes in relief, and changes in the native plant community. were visible on the spectral maps. Results: 1) Many map unit boundaries were more precisely located; 2) A better correlation between large remote areas was obtained; 3) A 25% overall reduction in ground sampling sites needed for map unit boundary delineation was obtained using the spectral maps

10. Project Plan. Soil Landscape Analysis Project (SLAP) \*
Implementation \* January 1984; U. S. Geological Survey EROS Data
Center, Sioux Falls. South Dakota: Bureau of Land Management Denver
Service Center, Denver, Colorado; Soil Conservation Service. Washington
D. C.

The SLAP project was an effort to develop methodology to optimize the use of a digital georeferenced data base containing digital terrain and multispectral Landsat information for an order three soil survey. The procedures involved the generation of digital aspect and slope-class maps and generation of spectral class maps stratified to highlight soil surface colors from the digital terrain and Landsat MSS data. These were overlaid on topographic maps and adjusted. These were then overlaid on orthophotos. where the soil surveyors completed the photo interpretation to produce soil pi-e-maps. The pre-maps ware digitized and incorporated into a digital data base in order to list. in tabular form, attributes of the pre-mapping polygons such as slope. aspect, and acreage data. The field mappers confirmed or refined map unit boundary placement to generate final soils maps which were also digitized.

11. Landsat Remote Sensing Project \* Soil Survey Application \* M. J. Zielinski. T. E. Bowles. R. D. Stager, L. B. Hall; USDI-BLH. Nevada

The **objective** of this study **was** to use the **Landsat** digital analysis and ancillary data to increase the efficiency and accuracy of the soil survey procedure. Digital data **was** stratified to highlight 18 broad features of land forms and parent material combinations. The efficiency and productivity of the soil survey effort was about the same as a conventional order 3 soil survey effort. Uae of **Landsat** increased the cost, but didn't increase or decrease the overall time spent on the survey. The additional data aided **in some** areas in placement of mapping ""it boundaries.

12. <u>Soil Survey Pre-Mapping Techniques Utilizing Digital Imagery</u> R. C. **Herriman,** M. S. Yee, O. A. Chadwick and **M.** C. **Parton** USDA-SCS and University of Arizona; Agronomy Abstracts.

A framework of questions and important items for scientists interested in soil survey pre-mapping techniques utilizing digital image analysis. Items covered include obtaining imagery. equipment, and computer expertise; examples of data collection and manipulation; example of stratification of data by geomorphic surfaces, soil moisture and temperature regimes and soil parent materials; and output products

- 13. In Mississippi a proposal to **work** on developing methods and expertise of using remote sensing techniques as a means of obtaining needed resource inventory data has been written. Color Infrared slides taken in the spring and fall of the year were obtained from ASCS. These will be used to monitor land use changes for National Resource Inventory type inventories and for keeping current the resource data base.
- 14. Low Altitude Aerial Photography for Agricultural Management W. E. **Wildman,** Extension Soils Specialist; Land, Air and Water Resources; University of California. Davis; Experiment Stations Journal Series h'o. 6714

<u>Aerial Photography for Conservation Information</u> W. E. **Wildman;** Journal of Soil and Water Conservation; Sept-Oct. 1984; Vol. 39, No. 5

In California. W. E. Wildman has emphasized the use of low altitude aerial photos for agricultural management. Photography tailored to the individual needs can be taken from small aircraft at appropriate seasons or critical time frames with a 35 mm camera at relatively law cost. Color Infrared photo interpretation can be used, for example, to identify poorly drained areas in orchards. Salinity shows up as areas devoid of vegetation. Nutrient deficiencies can also be spotted. All of these attributes are usable in refining soil map unit boundaries. end in determining map unit composition. Similar specialized photography is also a" excellent tool for explaining the need for, and uses of soil survey information. Proper photographic documentation can be used to dramatize wind and water erosion. loss of important farmlands, the need for proper agronomic management. and many other applications of soil survey information.

15. <u>Improved Low Intensity Soil Survey Map Unit Design Using Large Scale Vertical Aerial Photographs</u> K. W. Hipple, W. D. Harrison; USDA-SCS, Idaho

Idaho soil scientists find large-scale photography to be a useful tool to supplement map unit design and documentation procedures. can identify, document, and quantify soil components where soil differences can be related to vegetation, landforms, or topographic features that are not visible, or are visible but not quantifiable on standard 1:24000 soil survey field sheets. Film scales of 1:1200 and 1:600 with 40 to 60 percent stereo end lap were taken. Dot grid counts were made of component features, and ground transect and photo enlargement measurements were compared for soil and vegetative percent map unit composition. Advantages were: 1) Soil map units in remote areas can be more thoroughly observed; 2) Individual bias in map unit design may be reduced; 3) Photos are permanent records of map unit transects; 4) Time spent completing area reconnaissance may be reduced by studying carefully selected photo-transects; and 5) Extent and component percentages of some map units can be accurately determined as a check to ground transects.

- 16. Using Ground-Penetrating Radar (GPR) to Increase Quality and Efficiency of Soil Survey Operations J. A. Doolittle; USDA-SCS NENTC. Chester, Pennsylvania. GPR can improve the efficiency of sampling and the quantity and quality of data used to determine soil map unit composition. It is faster and labor intensive. Several other geophysical methods Including electromagnetics, gravity, magnetics, resistivity, and seismic can provide continuous spatial measurements which can be used to improve the quality of transect data. The principal use of the GPR has been to estimate the composition of and to assess the variability of taxonomic classes and differentiate within established soil map units.
- 17. <u>Using Ground Penetration Radar to Study Soil Microvariability M.E.</u> Collins, J.A. Doolittle; Florida Agricultural Experiment Stations Journal Series No. 6714; University of Florida.

One soil type in Florida was studied, using the GPR. to determine variability of depths to spodic and <code>argillic</code> horizons. Computer-generated, two-dimensional contour maps and <code>three-dimensional</code> surface-net diagrams of the diagnostic subsurface horizons and relative surface elevations were produced. The use of GPR <code>was</code> shown to be an economical alternative when compared with conventional field techniques for obtaining <code>subsurface</code> soil variability data. Resulting computer-generated diagrams and maps can be used to select the most representative <code>pedon</code> for sampling, to display the <code>variability</code> of diagnostic subsurface horizons and surface elevation, and to characterize the composition of map units. Field time and expense were reduced substantially when the GPR <code>was</code> used to obtain the necessary field data.

18. Calibrating Ground Penetrating Radar Data For Soil Application T. M. Zobeck, J. G. Lyon, D. R. Mapes, and A. Ritchie Jr.: Soil Science Society of America-Journal, Vol. 49, 1985.

Documentation as to the appropriateness of the GPR for this type study **WAS** obtained when the system was tested in two Ohio soils to determine the accuracy of GPR measurements and to demonstrate a simple technique to calibrate the instrument. A metal auger was buried in the two soils at differing depths and the GPR **WAS** able to detect the auger's location consistently within 3 cm.

19. Identification of Soil Associations In South Dakota on Erts-1

Imagery F. C. Westin; The American Society of Photogrammetry Symposium

Proceedings, Management and Utilization of Remote Sensing Data; Sioux

Falls, South Dakota; Oct. 29-Nov. 1, 1973.

ERTS-1 imagery was found to be a useful tool in South Dakota for the identification of soil associations since it provided a synoptic view. Soil associations can be observed over most, if not all, of their extent. The large scene is important so that the effect of climate, topography, and geology on soils can be seen. Selecting typical sampling sites and checking on the homogeneity of the associations can be more efficiently planned. The imagery, taken every 18 days, gave data on relief. and changes in hydrology and vegetation which can be an aid in delineating and interpreting soil associations.

- 20. <u>USGS Side-Looking Airborne Radar</u> The radar beam can be aimed thus produce an image which may enhance the ability to interpret geologic structures. Imagery may be obtained either day or night. It also penetrates cloud-covered areas of the world where collecting conventional aerial photos is impractical.
- 21. <u>Video Image Analysis of Large Scale Vertical Aerial Photography to **Facilitate** Soil Mapping W. D. Harrison. P. F. **Biggam, M.** E. Johnson; USDA-SCS Idaho.</u>

Idaho personnel tested Video Image Analysis (VIA) of large-scale vertical aerial photography to facilitate soil mapping. A specialized aerial photography method and computerized measurement techniques are used to help soil scientists map soils affected by shallow ground water. Objectives were: 1) Acquire large-scale aerial photos of surface information important to the determination of soil drainage classes and soil series; 2) Use VIA to measure land surface information directly from the aerial photography; 3) Apply VIA data to supplement on-ground transect data for more accurate percentages of soil map unit components. VIA permits the measurement of widely distributed features from aerial photos not easily measured using conventional methods, e.g. dot grids or planimeters. VIA is used here to quantify land surface feature information directly from large scale vertical aerial photos. Imagery



APPENDIX 2: REMOTE SENSING PRODUCTS AND TECHNIQUES PRESENTLY IN USE FOR SOIL SURVEY

PRODUCTS AND TECHNIQUES	SOURCES
National High Altitude Photography (NHAP) Black and White and Color Infrared.	EROS data center; USGS; ASCS
Special Low Altitude <b>35mm</b> and <b>70mm</b> Photography - Black and White, Natural Color, and Color Infrared.	Private contract
Panchromatic photography .57 um Panchromatic photography .67 um	Private contract
Black and White Infrared photography .79um.	Private contract
Color Infrared Photography .59 um	Private contract.
Digital Elevation Module or Terrain Data and associated products: Aspect maps Slope maps.	USGS; BLM Denver Service Center; EROS data center
Landsat MSS data, Landsat TN data, ERTS Imagery	USGS: University; EOSAT Corp.; BLH Denver Service Center
<pre>Landsat products: Spectral Class maps Black and White Symbol maps</pre>	USGS; University; EOSAT Corp.; BLM Denver Service Center
Digitized Soil Maps and associated products: Interpretive maps Digital Date Summaries	Private contract; In - house capability
Ground Penetrating Radar	Private contract; SCS-NENTC; <b>Geo-</b> physical Survey Systems Inc.; Univ. of Alaska.
Side Looking Airborne Radar	USGS; NASA
Video and Digital Image Analysis	University; In - House; Private contract.

Heat Capacity Mapping Mission Thermal
Infrared data

NASA

Meteor Burst technology for continuous monitoring and data transmission from remote sites

SCS -SNOTEL; Meteor Comm. Consultants; Scientific Eng. Instr. Inc.

# COORDINATION OF DATA BASE SYSTEMS Committee Report

Western Regional Cooperative Soil Survey Conference June 23 - 26, 1986 Portland, Oregon

25

#### Recommendations:

1. To the 1987 National Cooperative Soil Survey Conference steering committee - DEVELOP AN AGENDA THAT WOULD LEAD TO FORMALIZING ACTUAL COOPERATIVE WORK IN ACCESSING AND DEVELOPING NCSS SOIL DATA SYSTEMS.

The agenda should focus on national coordination and implementation of the following recommendations.

2. ADOPT A POLICY TO STRENGTHEN, INITIATE, OR EMPHASIZE COOPERATIVE WORK ON SOIL DATA SYSTEMS AMONG AND WITHIN COOPERATING AGENCIES.

National MOU's should be reviewed to determine if specific language is needed to facilitate cooperative work and access to NCSS soil data systems. Cooperators should be encouraged to review their internal direction to make sure barriers do not exist, and to add emphasis for cooperative work and access as needed.

3. INSTALL A NATIONAL COMPUTER FILE OF ACCESS INFORMATION FOR SOIL DATA FILES, PROGRAMS AND SYSTEMS FOR NCSS USE.

Hove the "Soil Data **Files"** material contained in NSH Part 606 to the computer file, update as necessary, and add similar information for each NCSS cooperator. Also include a contact person for each entry.

- 4. REVISE NSH PART 606 TO INCLUDE A DESCRIPTION OF THE NATIONAL SOIL DATA COMPUTER FILE AND SCS SOILS BULLETIN BOARD, AND HOW TO ACCESS AND USE THEM.
- 5. IDENTIFY INDIVIDUALS IN EACH COOPERATING AGENCY THAT ARE RESPONSIBLE FOR SOIL DATA PROGRAMS (primary contact person(s) by cooperator).

Include their name, number and general description of the soil data program **area** they work with in the national soil data computer file.

6. CHARTER A NCSS SOIL DATA BASE WORKING GROUP TO MEET PERIODICALLY TO ACCOMPLISH SPECIFIC TASKS.

The task group should be composed of individuals representative of soil survey cooperators and have soil data system responsibilities or experience. This could be a" extension of the existing SCS soil data workshop by adding a representative from each cooperator. In addition to tasks identified by cooperative soil survey conferences, other charges could include:

- Evaluate existing soil data definitions and systems, and propose measures for coordinated input, access, update and maintenance.
- Explore details for interagency networking as a method to exchange data and knowledge.
- Actively explore the application of emerging technology (e.g. electronic soil survey reports and laser disks).

### Charge 2 - Identify training needs and sources.

Training needs are described in the 1984 Committee 7 report. are providing some training in soil data systems. Still there is a lack of knowledge of available systems, programs, applications, and training opportunities. Some training is available locally from schools and businesses in the use of various microcomputer software. workshops sponsored by state NCSS committees is an effective and low cost method for interagency training on specific soil related applications. California is sponsoring such a workshop in October 1986.

### Recommendations:

- 7. THE WNTC SPONSOR OR COORDINATE INTERAGENCY WORKSHOPS TO FURTHER THE UNDERSTANDING AND APPLICATION OF AUTOMATED SOIL DATA SYSTEMS.
- 8. WNTC AND COOPERATORS PROMOTE THE "DETAILING" OF INDIVIDUALS TO MCATIONS WHERE SPECIFIC SYSTEMS ARE OPERATING TO GAIN "HANDS ON" EXPERIENCE.
- 9. To the 1986 conference business meeting CONSIDER SOIL DATA BASE MANAGEMENT AS A THEME FOR THE 1988 CONFERENCE. Also consider Colorado as a possible location because of the many cooperator systems located in the Denver and Fort Collins area.
- 10. THIS COMMITTEE BE TERMINATED. UNLESS THERE IS NO ACTION ON THE ABOVE. THEN IT SHOULD BE REFORMED TO FIND ANOTHER WAY TO DO IT.

### Committee Members:

\*Al Amen

BLM, Denver Dave Anderson SCS, Fort Collins \*Tom Collins FS. Ogden SCS. Salt Lake City Joe Downs \*Earl Ford FS, Juneau FS, San Francisco, Chairman \*Chuck Goudey \*M. Bruce McCullough SCS, Denver **FS**, Washington, DC SCS, Albuquerque John **Nordin** \*Tommie Lee Parham \*Bill Reybold SCS, Washington, DC \*Charles A. Reynolds SCS, Portland \*Wayne Robbie FS, Albuquerque Wally **Zahn** SCS, Portland

<sup>\*</sup>Attended conference

Conference committee: Review the National Cooperative Soil Survey (NCSS)

Program

Chairman: James A. Carley, State Soil Scientist

Soil Conservation Service

Spokane, Washington

George Green - (SCS-OR)
Phil Derr - (SCS-WY)\*
Herb Holdorf - (USFS-MT)
Bobby Richardson - (SCS-MT)\*
Dave Smith - (USFS-CO)

\* - Did not attend the conference June 23-26, 1986.

### Charges:

- (1) Evaluate current NCSS standards and procedures with an eye towards eliminating unnecessary activities and streamlining others to accelerate the once-over mapping of all lands to meet the NCSS standards.
- (2) Suggest ways map compilation and finishing can be improved and accelerated. Included could be ways to automate and accelerate the processing materials at the National Cartographic Center.
- (3) Look at ways to accelerate soil survey editing of original materials, i.e., public information officers, universities, etc.

# Report of Conference Committee Review the National Cooperative Soil Survey (NCSS) Program June 26, 1986

### Introduction

Other evaluations of the soil survey program of the Soil Conservation Service within the National Cooperative Soil Survey Program (NCSS) are underway. The evaluations are looking at means to carry out soil survey program responsibilities and at the potential for improving productivity. The A-76 study solicited comments from randomly selected soil scientists.

The soil survey program includes a wide diversity of activities and related duties. There is also wide variation in organizational structures and individual assignments.

This committee attempted to focus on the charges identified for the committee, and specific interests of the committee members was also considered.

The committee responded by correspondence to the charges early in 1986. The responses were summarized and served as a focal point for the committee meeting end discussion at this conference. Three committee members were not present at the conference, which hampered the correct interpretation of their comments by the other committee members present.

The charges of the committee are broad in scope and the response to the charges were diverse and controversial between individuals and agencies. Each. of course, has many good ideas and recommendations, but resolution and agreement by all on the committee **were** not profound.

### Charges and Recommendations:

<u>Charge 1</u>: Evaluate current NCSS standards and procedures with an eye towards eliminating unnecessary activities and streamlining others to accelerate the **once-over** mapping of all lands to meet NCSS standards.

Recommendations:

- 1. Utilize computer technology as rapidly and efficiently as possible. Provide available software and training.
- 2. Restructure the NTC **assistance provided** in the correlation process to **include the** second or third progress field review and comprehensive review. Attendance at the initial and final field reviews could be optional.
- 3. Combining the final field review and final correlation.
- 4. Combining the **SCS-SOI-5** and OSBDS **FILE**. Revise the setting statement on official series and **SOI-5** form to be the same.
- 5. **Recommend** a committee to evaluate the alternatives to publication as electronic transfer of data in lieu of publication.
- 6. Provide soil scientists with intensified training in remote sensing and photo interpretation and ground truth for remote **sensing**.

- <u>Charge 2</u>: Suggest ways map compilation and finishing can be improved and accelerated. Included could be ways to automate and accelerate the processing of materials at the National Cartographic Center.

  Recommendations:
  - 1. The map compilation should be done at the soil survey office by the field soil scientist or by someone under very close supervision of the soil scientist.
  - 2. Return the map finishing functions and responsibility to the National Cartographic Center for in-house work or for contracting under their responsibility.
  - 3. Reduce the detail and/or marginal information on published soil survey maps.
  - 4. The National Cartographic Center to act as a "clearing house" between states and agencies that have cartographic staffs, but could have a lull in their workload and those states/agencies that have insufficient staff for their workload for a specific time.
- <u>Charge 3</u>: Look at ways to accelerate soil survey editing of original materials, i.e. public information officers, universities, etc. Recommendations:
  - 1. Eliminate various sections from the manuscript such as climate and history sections that are not contributing directly to the needs of the soil survey.
  - 2. A committee be assigned to review specific soil survey manuscripts that vary in different ways from the normal NCSS publications. The committee should consider policy changes and/or identify the changes needed in the manuscript and how these changes can be accomplished so that the manuscript can meet NCSS publication quality standard. If the technical information, series, mapping units, and interpretations meet NCSS standards. there should be no problem in how its displayed.

# Special Task Force:

**Soil** Survey **Procedures--Verification** of Map Unit Composition

Western Regional Cooperative

Table 1.

Region

1. Survey order

2. Compo-

\* in addition to complexes

2

32.

desired coefficient of variation. Confidence level can vary as a function of the order of the survey. For example:

<u>Order</u>	<u>Confidence level. %</u>
1	90
2	80
3	70

Responses from the Soil Conservation Service are summarized in Table 2. Specific methods identified by various states will be examined in the next section of the report.

### **Yalidation methods**

<u>Air photo interpretation</u> is used primarily as an aid in making initial delineations and for placing delineation boundaries in higher order surveys. Delineations are not observed directly.

Observations can be of two types: 1) observation of surface characteristics including vegetation, surface coarse fragments, soil color, and landform by a drive-through, scan with binoculars, or helicopter fly-by, and 2) soil observation where the soil characteristics are noted from a pit, auger boring or road cut. Each component of the map unit may or may not be observed.

<u>Traverses</u> require that the mapper enter the delineation and examine each component of the map Unit. Location of observations is based on the perception of 'where the components occur on the landscape. Traverses are used to identify the components of a map unit and to test delineations made by air photo interpretation. Two types of traverses, random block evaluation and random map unit evaluation, have already been discussed.

Transects are used to determine % composition of the components of a map unit and to aid in the naming of map units. Alternatives to transecting include estimating proportions of soils from scattered observations made during the course of mapping or making detailed maps 01 selected areas showing all taxonomic units present, then determining the area of each component by planimetry. The former method is inaccurate and the latter too time consuming to be satisfactory for routine mapping (Johnson, 1961). Several methods of transecting and the statistical analysis of data collected from the transects will be discussed. Other methods used to determine map unit composition, test map unit purity, and measure soil variability will also be considered.

Table 2. Summary of methods used to verify map unit composition, Soil Conservation Service.

<u>State</u>	Method	Comments
Alabama	Transect (Steers and Hajek)	3 per map unit
Arizona	Transect (Johnson)	> 1 per map unit
Connecticut	Cornell and Malne methods	Northeast Region study of map reliability methods
Florida	Transects (Steers and Hajek)	Ground penetrating radar usedtoruntransects
Illinois	Transects, field notes	
Kentucky	Transects (Steers and Hajek)	5-IO per map unit
Montana	Transects, traverses, photos	
Nevada	Transects, traverses, observations, photos	Transect method varies with accessibility
New York	New York and Maine methods	Northeast Region study of map reliability methods
North Dakota	Transects	7-12 per map unit based on acreage, statistics of Cline or Arnold
Pennsylvania	Transects, field notes, New York method	Northeast Region study of map reliability methods
South NTC	Transects (Steers and Hajek)	Usually S-10 per map unit
Wyoming	Transects, traverses, field observations	

Number of steps Kind of soil

Transi

of steps assigned to each kind of soil is proportional to the area of each kind of soil within the delineation. (Also see Appendix 2).

Permissible limits of error in estimating the proportion of components depend on the proportion of the total area occupied by a given component. The number of transects per delineation and the length of each transect increases as the irregularity and intricacy of soil patterns increase.

Proportion of MU occupied	
<u>by component</u>	Allowable error. %
0.3-0.9	10
0.05-0.3	<b>≤20</b>
<0.05	<b>∠</b> 50

made. The population for final random Sampling is the total available transect population designated on maps. The number of transects selected is determined based on data from the initial sample. Data from the final set of transects is analyzed in the same manner as the initial data and is used in manuscript preparation.

Results illustrating the method from Steers and Hajek (1979) are presented in Tables 3 and 4. The guideline for conventional method transecting was a minimum of one 10-observation transect per delineation and at least one 10-observation transect per 284 ha mapped.

Two of the important limitations of this method are: 1) this method is not designed for location of soil boundaries, and 2) the soil survey is conducted with a specific land use in mind. Based on experience with this method, the following conclusions and suggestions are offered:

- 1) Five transects per map unit will be adequate only a small percent of the time.
- 2) If data analysis indicates that IO-14 transects are needed, the map unit may need to be divided into two units.
- 3) If analysis indicates 15 or more transects are needed, unit Is too variable and should be divided.
- 4) Complete data must be collected at each observation point, including soil characteristics, vegetation and geometric landscape features.
- 5) In dissected, level-bedded **terrain**, diagonal transects from base of the map unit to the top give the best coverage of landscape components in relation to proportion of occurrence.

Edmonds et al. (1985a) used a <u>nested sampling design</u> (Fig. 1) to <u>determine</u> the contribution to total variance of the <u>variance</u> due to delineation, due to site, and due to profiles in map units from the Piedmont, Coastal Plain, and Rldge and Valley regions of Virginia. The percent of total <u>variance</u> contributed by each of the above three components was estimated by dlvldlng variance contributed by each component by total variance. The variances contributed by delineatlons, sites and profiles, respectively, were estimated by:

$$\sigma^2_D = (MS_D - MS_S)/bcr,$$
  
 $\sigma^2_S = (MS_S - MS_P)/cr,$   
 $\sigma^2_P = (MS_P - MS_P)/r,$ 

where MSD is mean square for delineations, MSS is mean square for sttes, MSp is mean square for profiles, MS, is mean square for error, r is number of reps, c is number of profiles per site, and b is number of sites per delineation. Residual variance is estimated by MS, Total variance was estimated by summing the four component variances. Several physical,

**Table 3.** Comparison of means and sample size by random and conventional procedures for two mapping Units in Talladega Co., Alabama (Steers and Hajek, **1979**).

		Sample			
	Random	method	Conventional method		
Series	laitel	Final	Report?		
	Tallapoosa Tatum essoc hilly				
Telispoose					
math (%)	68 a 81	62 ± 6	66		
calculated a	2	2			
n excepted	6	6	133		
Tetum					
mean (%)	20 ± 6	28 ± 6	18		
celculated n	4	B.			
a sampled	6	В	133		
	Tellepoor	e-Tatum t	omplea, 6-16% elopee		
Tellepoose	·				
Distant (%)	63 ± 14	58 a 4	82		
calculated a	3	2			
n sampled	4	8	26		
Tetum					
meen (%)	33 ▲ 9	36 ± 9	31		
calculated n	•	3			
n aampled	6	8	26		

<sup>†</sup> Values taken from Cotton et al., 1974.

Table 4. Man-day effort comparison between random and **conventional** transect methods (Steers and Hajek, **1979**).

Kethod	Sample size	Point observations	Man-days required
Conventional?	259	3,685	159
Random	23	230	23

<sup>†</sup> Conventional data from Talladega County Soil Survey (Cotton et al., 1974)

<sup>\$ 80%</sup> confidence intervals

a number of transects or sample size.

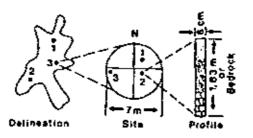


Fig. 1 Diagrammatic representation of the nested-sampling design. Three delineations with three sites per delineation and three profiles per site. Distances between profiles were \$7m (Edmonds et al., 1985a).

chemical and mineralogical properties of the soils collected were measured and the variance of the means calculated. Results show that mutually exclusive units of these properties were not delineated by the map units tested. In most instances the small map scale prevented the mapping of distributions of these laboratory determined properties as well as variability in observable soil properties that exhibit variation over short distances. They conclude that attempts to make ranges in soil properties in map units correspond to ranges defined for official soil series are pointless because soil properties do not lend themselves to hierarchical arrangement and small map scales prevent their being mapped.

The nested sampling design has been combined with the point-intercept transect method to study soil map units in the Adirondack Mts. of New York (R. C. Somers, personal communication). Three soil pits, arrayed along the contour, are examined in a 0.08 ha plot at each stop along the transect. Preliminary results show that transects that do not include observations of the horizontal variability over short distances overestimate the purity of the map unit. In areas where soil patterns are complex, broader map units should be designed to accommodate dissimilar inclusions.

Purity of consociation map units of soils with pachic mollic epipedons (Calcic Pachic Argixerolls) in northern Utah was tested using a <a href="mailto:chi-square">chi-square</a> method (Badamchian, 1978). The map units contained soils with mollic epipedons (50 cm thick. Selected delineations were gridded; data collected were the proportions of samples that fit the characteristics of 1) the named soil, 2) inclusions, 3) the named soil, except for thickness of epipedon (misclassified), and 4) neither the named soil nor named inclusions (not classified). The statistical analyses were conducted with

the assumption that **75%** of the observations would fall within the range of characteristics of the named **5011**. Tables 5 and 6 summarize the results of the field observations and the statistical analyses.

The test of goodness of fit proceeds as follows:

```
Ho: proportion of named soil = 0.75
Ha: proportion of named soil \neq 0.75
Reject Ho if X^2 > X^2_{(k-1)(1-8)}, where k = 2, a -0.05
X^2 -61.48
X^2_{(1)(0.95)} = 3.84
```

Since the calculated chl-square is greater than the critical value, the Ho is rejected. By inspection, the proportion of the named soil is much less than 0.75. The confidence interval for the above proportion is

P ± 
$$z_{8/2} \sqrt{(pq/2)}$$
; p = 86/175 = 0.49,  
q = 1 + 0.49 = 0.51,  
z = 1.96  
0.49 ± 1.96  $\sqrt{(0.49)(0.51)/2}$   
0.47 < D < 0.56

The proportion of the named soil is somewhere between 0.42 and 0.56, with 0.95 conf Idence.

Geostatistics have been used to quantify spatial variation in soll properties (eg., Campbell, 1978; Yost et al., 1982). The extent to which properties at a point represent the unsampled neighborhood depends on the degree of spatial dependence that exists among samples. Semivariograms are used to measure spatial dependence. A semivariogram is a plot of the semivariance vs. distance between measurements. The average rate of change of a property over distance can be estimated by the semivariance (1). For a sequence of measurements (Y) equally spaced at interval h, the semivariance is (Campbell, 1978):

$$\gamma_{h} = 1/2\Sigma [(Y_{(i+1)} - Y_{(i)})^2]$$

The semivariance is equal to one-half of the expected value of the squared differences between values of Y at locations(1) and (1+j), and is calculated

Table 5. Summary of results of **observations** for mapping **unit**.

Category	No. of Samples	
Named sol I	86	49. <b>1</b>
Inclusions		
Α	6	2.4
В	20	11.5
Misclassified	49	28.0
Not classified	14	8.0
Total	175	100.0

Table 6. Summary of chl-square **analysis** for map **unit** components.

Classification	Observed	Expected	$(0-E)^2/2$
Named soil	0 <sub>1</sub> =86	E <sub>1</sub> =175(75/100)=131	(86-131) <sup>2</sup> /131=15.46
Not named soil	02=89	E <sub>2</sub> =175-131=44	(89-44) <sup>2</sup> /44=46.02
Total	175	175	$X^2 = \Sigma\{(0-E)^2/E\} = 61.48$

for integer multiples of h, with samples always selected to form a straight line. Fig. 2 is an idealized semivariogram, which is a plot of semivariance against distance measured in multiples of h.

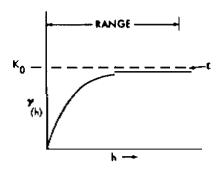


Fig. 2. Idealized semivariogram (Campbell, 1978).

At distance L, the range, the semivariance reaches a maximum and remains constant. The range is defined as the distance at which semivariance approaches to within an arbitrary small distance,  $\epsilon$ , of the maximum variance, Ko.

Two soils in Kansas, Ladysmith (Pachic Argiustolls) and Pawnee (Aquic Argiudolls), were grid sampled at 10-m intervals (Fig. 3). Sand content and pH of the B horizon were measured and semivariances calculated. Semivariograms are shown in Fig. 4.

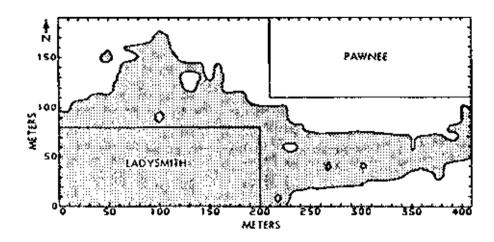
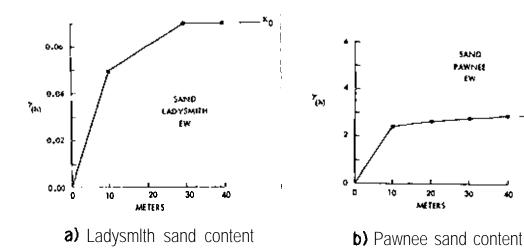


Fig. 3. Detalled map of the boundary between the two mapping units (Campbell, 1978).



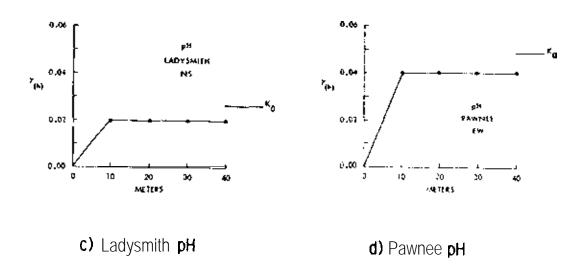


Fig. 4. Semivarlograms for sand content and **pH** of Ladysmlth and Pawnee **soils** (Campbell, 1978).

Both properties have much higher semivariance in the Pawnee area than the same properties in the Ladysmith area. Semivariance for the Ladysmith sand content attains its maximum at a distance of 30m. For the Pawnee sand content, semivariance does not become constant even at 40m. This means the subarea is not large enough for accurate estimation of sand within the Pawnee area; a larger sampling area is required. Full variability of sand content is attained within a distance of 30m in the Ladysmith area; in the Pawnee area, a distance of at least 40m is required to determine the full variation in sand content.

The semivarlogram for pH has a higher maximum in the Pawnee area than in the Ladysmith area. Maximum levels are attained at the first sample point, a distance of 10m, and indicate an absence of continuity between adjacent samples. Closer sample spacing is required to determine the continuous variation in distribution of pH values.

Geostatistics can be used to measure the variation in soil properties within map units and the information obtained from the intensive study could be applied to other similar soil bodies, provided it is possible to define relationships between the place-to-place variation and directly observable soil or landscape features, The method can also be used to get an approximation of the number of samples needed to estimate mean values of a property at a specified level of accuracy and confidence and to determine the spacing at which samples should be taken.

Three methods used to test <u>map reliability</u> will be reviewed briefly. These were methods developed and tested in the Northeast Region. The <u>Cornell</u> method (Appendix 3) was developed for SMSS to aid developing countries in assessing the quality of Soil Resource Inventories. Detailed procedures are given in the SMSS Tech. Monograph 4 (SMSS, 1979). Ground truth procedures compare expected with observed selected soil properties at a minimum of 30 points per map sheet. Each selected property at the site is is given a numerical score based on how closely the predicted and observed property compare. The scores are summed for all points on the map sheet. At a 90% probability level, a Purity rate of 250% and a strongly Contrasting rate <15% are required for acceptability.

The method evaluates both the purity level and error rate of the soil map, quantifies those soil qualities evaluated for a specific purpose and has a strong statistical standard. The method does not evaluate the accuracy of soil map boundaries, it is quite time consuming (10 days to make one 30-point evaluation), data gathering may require the expertise of a soil scientist, it does not evaluate how well the soil map unit description documents the soil-landscape features, and it may bias the evaluation

toward larger map units--points In small or narrow units may be rejected because they fall too close to the boundary.

The <u>New York</u> method (Appendices 4 and 5) evaluates maps based on the magnitude of error and the number of errors per minimum size dellneatlon. Approximately one square mile is evaluated per map sheet. Field sheets are transected; each map unit crossed is examined. Estimates are made, based on landforms, of the number of acres deviating from or at variance with the expected predetermined soil features. Results for each map sheet are compared to the allowable number and sizes of variance allowed for each feature class. If the number or size of variance exceeds the maximum allowable value, the map is considered to be unacceptable.

This method is rapid (seven hours per sheet), it may have value as a training aid in Identifying areas where **soil** scientists have trouble properly **classifying** a certain soil property, it evaluates features important to the functional **quality** of the map, it evaluates both boundary errors and **classification** errors, and it provides a concrete evaluation (acceptable or unacceptable) of map adequacy. The method has a weak statistical basis, the allowable variance table is often too **restrictive** and needs **revision**, and map unit composition and cartographic quality are not evaluated.

The <u>Maine</u> method (Appendix 6) provides an error rate per square inch of the map sheet. Ten items are evaluated and weighted for the seriousness of the error. Ten to twenty percent of the map area is randomly selected for evaluation. The error score is totaled and compared to a previously established tolerable error limit score. The procedure uses the same field procedures as the New York method. In addition, cartographic and map unit evaluation items are reviewed in the office. Using this method, an error rate per square inch of a map determined to be "unacceptable" by the New York method (18.2 vs 10.4 per square inch). A score range could be chosen to mark the acceptable-unacceptable limit.

This method is the least **time** consuming, It combines cartographic and map unit description evaluation with map unit IdentIfIcation and boundary placement, **it** can be **applied** to any scale map, and it evaluates **field** sheets of ongoing surveys. It lacks statistical **establication** 

### References

Arnold, R. W. 1979. Strategies for field resource inventories, pp. 61-92. Mimeo 79-20. Dept. of Agronomy, Cornell Univ., Ithaca, NY.

Badamchian, B. 1978. Mapping reliability of some pachic soils in northern Utah. Unpublished MS thesis. Utah State University, Logan.

Campbell, J. B. 1978. Spatial variation of sand content and pH within single contiguous delineations of two soil mapping units. Soil Sci. Soc. Amer. J. 42:460-464.

Cline, R. G. 1981. Use of probalility and occurrence in evaluation of map units. Soil, Air, and Water NOTES, 81-2. USDA, Forest Service, Northern Region, Missoula, MT.

Edmonds, W.J., S.S. Iyengar, L. W. Zelazny, M. Lentner, and C. D. Peacock. 1982. Varibility in family differentia of soils in a second-order soil survey mapping unit. Soil Sci. Soc. Amer. J. 46:88-93.

Edmonds, W.J., J.C. Baker, and T.W. Simpson. 1985a. Variance and scale influences on classifying and interpreting soil map units. Soil Sci. Soc. Amer. J. 49:957-96 I.

Edmonds, W.J., J. B. Campbell, and M. Lentner. 1985b. Taxonomic variation within three soil mapping units in Virginia. Soil Sci. Soc. Amer. J. 49:394-401.

Johnson, W. M. 1961. Transect method for determination of the composition of soll mapping units. Soil Survey Tech. Notes. USDA-SCS.

Soil Management Support Services. 1979. Guldelines for evaluating the adequacy of soil resource inventories, chapter 4. SMSS Tech. Mono. #4, Cornel I University, Ithaca, NY.

Steers, C.A. and B. F. Hajek. 1979. Determination of map unit composition by a random selection of transects. Soil Sci. Soc. Amer. J. 43: 156-160.

Steel, R.G.B. and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill, New York.

USDA-Forest Service. 1980. Elementary statistical methods for foresters. Agric. Handb. 317.

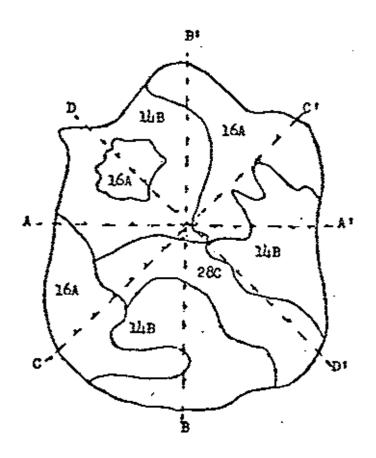
Yost, A. S., G. Uehara, and R.L. Fox. Geostatistical analysts of soil chemical properties of large land areas. I: Semi-variograms. II: Kriging. Soil Sci. Soc. Amer. J. 46:

# Appendix 1 SOIL MAP UNIT COMPOSITION

1.	Order of Survey (NCSS co. 1, 2, 3, 4, or 5)
2.	Composition of Map Units (a, b, or c)
	a. Associations of Soils
	b. Soil Series (or other monotaxal components) and complexes
	c. Other
3.	Taxonomic Level of Soil Identification in Legend
4.	Method of Determining Hap Unit Composition
	a. Traverses
	b. Transeots
	c. Spot observations
	d. Air photo interpretation
	e. Combination of above, specify
	<b>f.</b> Other
5.	Are some map units verified by independent methods?
	If so, what percentage of the map units are verified?
	Hethod of verification (a, b, c, d, e, or ffrom Question 4)

Soil	True	Line-Intercept		Point-Intercept	
	nt Proportio	n Lengo	h Est.	No. of Est.	
Symbol	of Total		Proportion	Stops <b>P</b>	roportion
		4	L <b>of</b> Ârea	·	of Area
16A	34.4%	281	33.4%	23	36%
148	49.7%	394	47.1%	29	45%
28C	25.5%	162	19.3%	32	19%

Comparison of estimated proportions, using line-intercept and point-intercept methods, with true proportions in a sample map delineation.



### Appendix 3

## CORNELL - SCS METHOD

## SRI Evaluation For **Major** Urban Interpretations

Middlesex County, Connecticut - Atlas Sheet 33

A, B, C, D, and E Predicted Soil Properties -- () Observed Soil Properties

COMPONENT				<u> </u>
SOILS	DEPTH	STONINESS	FLOODING	SCORE
1. Hollis - Charlton	A <b>(A)</b>	8 <b>(C)</b>	A (A)	2
2. Charlton - Hollis	c <b>(C)</b>	E (B)	A (A)	3
3. Charlton - Hollis	A (A)	8 <b>(B)</b>	A (A)	1
4. Hollis - Rockoutcrop	c <b>(C)</b>	8 <b>(C)</b>	A (A)	2
Etc.				
25. Charlton - Hollis	A <b>(A)</b>	E (E)	C (A)	4
Etc.				
30. Hollis- Rockoutcrop	c (C)	c <b>(c)</b>	A <b>(A)</b>	3

TOTAL: 67

AVERAGE: 2.23

SCORE: 1- All Correct

**2-≤** 2 Adjacent Classes

3- > 2 Adjacent Classes or 1 Non-Adjacent Class
4- > 1 Non-Adjacent Class

PURITY =	

Transect #1

### NEW YORK METHOD

Photo ≠ 2JJ-87

Evaluated by: Work,

MAP ACCURACY CHECK

Sliverman, Hanna

Date: 9/28/83

Mapped by: Silverman

0 - No deviations 1 - One deviation from normal 2 - Two deviations from normal

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THE CHAIR IN						
Stop No.	Map Unit	Depth to Rock	Drainage Glass	Family Texture	Slope	Acres Deviating
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#### Appendix 5

# SOIL MAP ADEQUACY TABLE (NEW YORK METHOD)

# Class Variances and Size of Variances Allowable (in 1 sq. mile area) for Common Soil Feature Classes

Area Evaluated -SaratogaCounty, New York, S.S.

	Class	Maximum Number Eauivalent Minimu Size Delineations Having Indicated Variance to be	m- Field Sheet	Field Sheet
Soil Feature Class	Variances	Acceptable	2JJ-87	2JJ-7
Depth to Bedrock or	1 .	5	****	
Impervious Layer	2	2		<b></b>
	3	1		<del>ul line</del>
Natural Drainage Class	1	F	_	_
Matarar Brainage Glass	•	5 .	1	2
	2	2	_	-
	3	1		_
Flood Hazard	1	2		5
Family Textural Class	1	а	7	а
,,	2	2	2	_
	3	1	<del>-</del>	
Slope Class	1	6		4
	2	3		-
	3	1		
(Reaction. stoniness ar	nd surface		Acceptable	Unacceptable
texture also evaluate	ed.)		(20 obs.)	(16 obs.)

#### Appendix 6

## MAINE METHOD

### AREA EVALUATED - SARATOGA COUNTY, NEW YORK, 9.3.

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1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		No. o	of Errors	1	
ltem ≃ o <sup>t</sup> o	Telaur	Per Sq	. Inch	s	core
1. Map units not correctly identified.	2.5	2JJ-87 .13	<u>2JJ-7</u> .25	<u>87</u> .32	<u>7</u> .63
2. Map unit boundaries inaccurate.	2.5	.19	.25	.48	.63
3. Detail on map not adequate.	t.2				<u> </u>
4. Map unit delineations and symbols not neat or not legible.	1.8	<u> </u>	.18		.32
5. Soil boundaries not joined with adjacent sheets.	0.2			<del>-</del> .	·
6. Cultural features not in legend.	0.2			-	
7. Incorrect location of civilboundaries or cultural features.	0.2		Wirms		is g
8. Inaccurate isbeling of streams, rivers, etc., and cultural features.	0.2		•		
9. Map scale, N. arrows. acreage, map- per's name, etc., missing or in- accurate.	0.2		******		
10. Map unit description inadequate.	.21.0	.24		.24	.24
TOTALS	10.0			10.4	18.2

# WESTERN REGIONAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

Report, Task Force B: Future Role of NCSS Soil Scientists after Soil Surveys

Upon receiving notice of appointment to this Task Force, I had momentary concern as to the reliability of my crystal ball, as well as for those available to the team assigned! We have, however, looked deeply, pooled our perceptions and those of others to provide this view.

The starting point for the Task Force is provided in the charge from the Steering Committee, namely - "To determine the role of soil scientists after the once-over soil survey is complete". The "once-over" soil survey refers, of course, to the current NCSS goal to complete modern soil mapping of the entire United States by about the year 2000. The program is to produce surveys of Order 2 intensity for all arable or intensely used lands, and Order 3 or 4 intensity surveys for forest, range and watershed lands. Questions have been raised by some to the effect - once the mapping is done, what further need is there for soil surveyor scientists in governmental employ, in fact will not the need for a National Cooperative Soil Survey be at an end? To this there is one clear answer - "By no means!" Let us develop the rationale for this answer.

The opening talks for this Conference have addressed near future concerns and plans for the NCSS, some of which lead us toward the "once-over" goals. But this Task Force must try to look beyond this into the first quarter or first half of the 21st. century. As an aside, it is appropriate that we give thought at this Conference to both the near and farther future of soil scientists and the NCSS, for this is the centennial year of the publishing of Dokuchaev's (1886) concepts of soil genesis and classification that marked the beginnings of developing soil knowledge as a science rather than an art. It is of further interest to note that it was a simple map of Russian soils prepared earlier by Chevlovsky, a renown naturalist of the time, that stimulated Dokuchaev.

There are various ways to make predictions of future events. One is by utilizing our past experiences and/or knowledge of past events and building upon these. Your Task Force has selected this method.

The record of the past 86 years of soil survey in the U.S. shows a sequential pattern of changes in the overall management and objectives of the survey that correlate interestingly with three important things that, in themselves, have progressively changed or periodically occured over time, and that can be expected to change or occur in the future. These are: 1) our  $k\underline{nowledge}$  and  $\underline{concept}$  of soils; 2) our  $\underline{methods}$  of viewing, perceiving, analyzing and mapping soils; and 3) the unforeseen emergence of kinds of land uses that will require documentation of previously unobserved or unrecorded soil information, as well as presentation of existing information in greater detail.

Soil survey work from 1900 to about 1913 had a strong geologic bias. An initial concept and definition of soil series and soil types were developed. Both were grouped into soil provinces largely akin to geologic or physiographic provinces. The initial concept of the series only vaguely resembled our current concept. In 1913 and shortly thereafter, two important events took place. Both had profound effects on soil survey at the time and for years to come. First - the automobile was introduced as a

tool for soil survey, initially in California and Nebraska and soon thereafter in other parts of the country. Second — and probably of greater importance — Curtis Marbut introduced to the survey concepts from the Russian school of soil science through his translation of Glinka's (1914) German publication on kinds of soil formation and soil groups of the world. Marbut also began formulating his own ideas and was so" stressing the importance of classifying soils mainly on a morphologic basis rather than on a genetic basis involving factors and processes. According to Macy Lapham (1949) — one of the first Western Inspectors for the Division of Soil Survey, Bureau of Soils —Marbut's action during this period sparked a revolution in thinking among soil scientists of the day. This was possibly similar to the stimulation and controversy many of us experienced in the early 60's with the introduction of the 7th Approximation.

From World War I years through the ealy 30's, we see a generation of soil surveys reflecting the concepts of soil classification and relationships to land use that are summarized in Marbut's (1935) Atlas of American Agriculture. Through his leadership soil series, as a concept, developed to a point much closer to that of the present day.

In the early 30's to 40's, aerial photos replaced topographic quads or plane table maps as field sheets, and Marbut's system of soil classification was replaced by the incomplete 1938 system of Soils and Men (1938). Annual and biennial conferences and committees were addressing numerous questions concerning criteria for consistent as well as improved soil characterization. Findings, conclusions and proposals from these groups culminated in the Soil Survey Manual (1951). During this period, a improved generation of soil surveys appeared.

The era of the "modern soil survey" had its beginning in the early 50's, implemented by the concepts in the then "new" soil survey manual. It was guided by an updated, but still unsatisfactory, 1938 system of higher category soil classification. Currently, we may view this period as "early modern". It lasted for about 15 years until the official adoption of Soil Taxonomy in January 1965. The present era in soil survey was ushered in at that time, and I'm sure from our own experiences, we are well aware of the further changes that have taken place in the past 20 years. These in turn have led, or are leading us to modifications in our ways of making the national soil survey. For a "umber of years we have considered soil surveys of post-1950 publication as part of the genre of modern surveys to be completed on reaching the "once-over" survey goal at the turn of the century. If at that juncture, we annouce the completion of the survey and the availability of the reports, point with pride to a job well done, but do no more, we will have failed our century-long task!

NOW, let us turn **our** mind's eye toward the future. Our historical perspective of the U.S. soil survey and **our** current knowledge indicate to us two areas of importance for future soil scientists following the "once-over" survey. One is national, the other is global.

Our current future view of the <u>national</u> area perceives the need for soil scientists in 5 important areas.

1. Soil scientists will be involved in updating, improving, or intensifying soil data in previously mapped areas. In days to come, new land uses, new information needs. new methods of securing information, and new knowledge aboutsoils will soon make many "once-over" soil surveys obsolescent or obsolete. If, as has been postulated by some, good soil surveys have a useful life of about 30

years, many, if not most of the "once-over" surveys will be in need of updating, particularly those completed and published during the 1950-1970 period. In addition, unfortunately, some surveys have been poorly done or the correlation process was bypassed. These could and should be high priority areas for re-survey.

- 2. Soil scientists will be improving, intensifying and extending our knowledge to interpret (predict) soil behavior. At the current rate of land development and changes or intensification in land use, there is eve" now an increasing need for competent soil scientists to study, gather data, and develop new or improved soil interpretations to guide management and to avoid or minimize mis-"se of the land. A" important part of this task is and will be getting the information into the hands of decision-makers in a palatable form that will encourage application. Soil interpretation is see" as a continuing need that will grow and require the talents of many well trained, as well as field-experienced soil scientists -assuming the nation's land ethic remains dominantly one of stewardship.
- 3. <u>Soil</u> scientists will be needed as local soil <u>resource</u> specialists to extend existing information and to work with local users. With more intensive land use, there will be need for something more than conservation-generalists or prescription technical guides to interface with land users and data banks. For efficiency and effectiveness, this area should be filled with soil resource specialists, soil scientists who are truly resident experts that can interpret existing soil information, as well as identify and work on previously unrecorded, but newly revealed facets of the local soilscape as an aid and service to users.

We must remember that in current Order 2 soil surveys, actual subsurface inspection of the soil continuum during routine survey is about 1 part in 10 million by volume, if, on the average, there has been at least one auger investigation site per 10 acres. ten-fold increase leaves most of the continuum unobserved. Accurate mapping does not rely solely on augered or excavated site information. but correlates other observable features as well to determine probable Map unit design in itself aids in determining the map "nit patterns. desired quality control for an area. However, with increased land use intensity in the future, the undersanding, determination and interpretation of inclusions in previously mapped ""its will be a focus of investigation for many soil scientists. This may also lead to decisions for more intense (Order 1) surveys of parts of previously mapped areas - calling for truly experienced soil scientists able to apply advanced techniques of the times.

4. Soil scientists will be involved in application and augmentation of automatic data processing systems in support of the three foregoing areas. Currently, we are presumably phasing out of a period in world history characterized as the Industrial Revolution and into an Information Revolution. The development of computers, models, data management systems and telecommunications is leading the way to make available methods and means of processing current stores of accumulated information in ever-increasing and, hopefully, efficient ways.

The probable fund of collected data upon completion of the "once-over" soil. survey alone can he staggering in terms of current thinking. Beyond this time, even more amassing of data can be envisioned. This points to the need of a newer breed of soil scientist, one well versed not only in pedology, but in the ways of artificial intelligence, cognitive science, and management theory. McCracken and Cate (1986) have outlined the possibilities of this intriguing field in the latest Soil Science Society of America Journal as it may relate to improving our abilities to handle vast amounts of soil data, and to understand better and to improve our system of soil classification.

5. Soil scientists will continue to conduct basic research and analytical services. Undergirding the operational activities of the National Cooperative Soil Survey in the 21st. century, as in the 20th. century, will be the continuing need for research into the nature, genesis, and behavior of soils, as well as for routine or special characterization analyses. There is a great deal we do not know about soils now, nor are we likely to have learned all we need to know within 25 to 50 years.

The link between NCSS and the Experiment Stations of the Land Grant Universities and other educational/research institutions must not be broken or weakened. It should be strengthened for mutual advantages. The field work of the NCSS provides a comprehensive means of unearthing the uncertain or the unknown about soils for cooperating researchers. Without this link, the solutions to our pedological questions in relation to the nation's use of its lands would be far less coordinated, more sporadic and less efficient in furthering our need to know. In addition, it is through this linkage that education and training of future soil scientists is effected. With increasing sophistication of science and technology, courses for periodic updating of professional soil scientists should become part of regular University Extension.

Our global perspective of the soil scientist in the 21st. century is based, in part, on current international interest and development in Soil Taxonomy. The Soil Management Support Services of the SCS, in conjunction with the International Benchmark Sites Network for Agrotechnology Transfer is reaching out to other countries and scientists involved in the soil classification and cartography activities of the Committees of the International Soil Science Society. SMSS is also involved with IBSNAT in the development of an ambitious system for eventual application - the Decision Support System for Agrotechnology In order to complete and validate this system, many disciplines will be called upon for input, not the least of which will be that of the There is enlightened national self-interest in this With estimates of world population approaching 5 billion by about the year 2000, and prospects of continuing increase in the years ahead, demand for arable land for food and fiber production and the intensity of land use will accelerate amazingly. We can look forward to significant stressing of the world ecosystem - and that can affect us all!

The need for effective land management strategies are apparent now and will become more demanding with time. Many possible future crises in our planetary environment will involve the soils of the world. To us, as soil

scientists, it is clear that systems such as Agrotechnology Transfer are a rational approach to such problems bringing to bear knowledge and experience of successful land management strategies from one or more areas of the world to other areas deficient in such knowledge or experience.

A recent publication, available through Science News, Inc., attempts a serious, and somewhat optimistic, projection of future times. It is titled The Third Millenium, A History of the World: AD 2000-3000. In it, the 21st. century is part of a nearly 200 year "time of crises" fueled by population increases, energy dislocation and shortages leading to great intensification of less-than-successful subsistence farming underdeveloped parts of the world, extensive deforestation, progressive desertification, and atmospheric degradation. A solution to these crises in food and fiber production, following an amelioration of and partial solution to energy needs, is postulated in this book as the result of developments in bio-technology and bio-engineering. No successful insightful mention is made of the vital role that knowledge of our soil resources might play in such a senario. We see in such predictions, unfortunately, a" all-too-prevalent lack of awareness in much of society of the importance of soil, in all its splendid variability, to the successful solutions of many land management and use problems.

With these thoughts in mind, we foresee the continuing need for soil scientists, well versed in pedology, soil behavior and interpretation to serve not only national needs, but international ""es as well. The development of technical classification systems for a variety of special needs in data processing may equal, and in places exceed, the continued development of the natural system of Soil Taxonomy. This is not to say that these systems should or will be antagonistic, but rather that they should be complementary and supportive.

Projecting beyond the turn of the century, will we eventually see a Global Cooperative Soil Survey of sorts? Will we see a Global Cooperative Extension Service? Only time can really tell!

We would like to close this report with the following (2001 Theme). Thus, gentlemen, spake **Zarathustra**, your Task Force's theme - looking forward to the year 2001 and beyond!

#### References:

 Dokuchaev, V. V. 1886. Report to the provincial authority of Nizhinii-Novgorod, no. 1. Main phases in the history of land assessments in European Russia, with classification of Russan soils.

2.

3.

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5.

6.

#### REPORT OF WEST REGIONAL SOIL TAXONOMY COMMITTEE

#### MAY 1984 TO JUNE 1986

#### COMMITTEE ACTIVITIES

- 1. Thor Thorson, SCS. Oregon, and Alan Busacca, Washington State University were appointed to serve on the committee to 1988.
- 2. Earl Alexander, FS. California. and Ike Ikawa, University of Hawaii will be retiring from the committee at this conference.
- 3. Reviewed 13 proposed changes or amendments to SOIL TAXONOMY. Most of these originated within the Western Region.
- 4. Reviewed a number of ICOM circulars or reports. At least 12 responses were provided by individual **committee** members to either the ICOM chairman or to our National Headquarters.
- 5. Chairman discussed various proposals and/or role of the committee with individual committee members.

#### OTHER ITEMS OF INTEREST RELATED TO SOIL TAXONOMY

- 1. The West NTC and the States of Idaho, Washington and Oregon are hosting the First International Soil Correlation Meeting (ISCOM), to be held here in the Pacific Northwest, July 21-31. 1986. As a part of this meeting, we will be testing the placement of U.S. soils in the proposed ANDISOL order. we will also be looking at the use and management of soils derived from volcanic material.
- 2. Talks are currently underway for a similar ISCOM in 1987 to study proposals being made by ICOMID International Committee on Aridisols. This meeting will be held in the southwest. The 2nd ISCOM will be formalized in more detail during the July meeting.
- 3. Dr. Ikawa and Harry Sato of Hawaii have reclassified the soils of Hawaii using criteria in the ICOMAND, ICOMOX, and ICOMLAC proposals. This is the only extensive testing of these proposals of which I am aware, in the Western Region at least.

#### ACTIONS TAKEN AT CONFERENCE

The following actions were take" by the committee at the West Regional Cooperative Soil Survey Conference, Portland Oregon, June 23 - 27, 1986.

1. Proposed that the West NTC staff develop and maintain a computer file of amendments that need to be made to SOIL TAXONOMY. These would be based on tentative classifications made at correlation conferences, or as proposed by the field or state soils staffs, or by NCSS cooperators. but not yet developed to the point that they become formal proposals. These proposals would be shared with other states or agencies, and if others have similar soils, a committee could be established to develop the formal proposal that would cover all concerned states and agencies.

- 2. Proposed that the West HTC develop and maintain **acomputer** file to track all formal proposals that have been submitted to the NTC. That periodic reports be sent to any concerned individuals. or they have access to the file to determine the status of specific proposals.
- 3. Koveris to poll the states to determine current active proposals to be included in the program (or to track down existing proposala then include them in the program). He will also request a list of soils that have tentative classifications in implied or nonexisting taxs to include in that computer file.
- 4. It was proposed that these files be housed on the WNTC's 3R2 unit for easy access by the states.

At the conference business meeting the following were elected to **serve** new 3 year terms on this **committee:** DR. GORDON HUNTINGTON. University of **California**, Davis, and **WAYNE** A. ROBBIE, USDA, Forest Service. Albuquerque, **New** Mexico.

RICHARD W. KOVER, Chairman West Regional Soil Taxonomy Committee



Soil Conservation Service West National Technical Center 511 N. W. Broadway. Rm. 547 Portland, Oregon 97209-3489

August 27. 1986

WEST NTC BULLETIN NO. W430-6-6

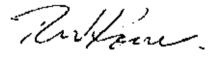
SUBJECT: SO1 - WEST REGIONAL SOIL TAXONOMY COMMITTEE

<u>Purpose.</u> To **announce** the newly elected members of the West Regional Soil Taxonomy Committee.

Expiration Date. When contents are noted.

Wayne Robbie, Forest Service. New Mexico and Gordon Huntington, University of California. Davis were selected to the West Regional Soil Taxonomy Committee for three-year terms beginning immediately and ending in 1988. They will be replacing Earl Alexander and Ike Ikawa whose terms expired this year. The makeup of the new committee is:

Dick Kover, Chairman	(permanent)
Wayne Robbie	1989
Gordon Huntington	1989
Thor Thorson	1988



## Report of Committee II Laboratory **Methods** Committee

Chair William R. Allardice

#### Members Present

★ W. Allardice	Univ. of <b>Calif,</b> Davis
☆ M. Fosberg	Univ. of Idaho, Moscow
* н. Ikawa	Univ. of Hawaii, Honolulu
J. Nielsen	Montana State Univ., <b>Bozman</b>
*C.Ping	<b>Univ.</b> of Alaska, Palmer
J. Simonson	Oregon State Univ., Corvallis
A. Southard	Utah State Univ., Logan

#### Visitors

R. Hopper Colorado

#### \*Laboratory Comparison Contributors

J. Demeterio	Univ. of Guam, <b>Manos</b>
T. Fenton	Iowa State Univ., Ames
D. Nettleton	NSSL-SCS Lincoln Nebraska
P. Sheets	Michigan Tech. Univ., L'Anse

#### Committee II

Application of Laboratory Methods Report - Summary

Presented to the 1986 Western Regional Work Planning Conference Portland, Oregon

#### 1982 - Charges

- Charge 1 Review current methods of soil analyses with respect to their effectiveness in identifying soil properties.
- Charge 2 Evaluate new methods of soil analyses and make recommendations to the Western Regional Work Planning Conference.
- Charge 3 Communicate problems and solutions to problems encountered in soil characterization analyses.
- Charge 4 Establish minimum standards for laboratory procedures.

#### Action

Reviewed three publications for soil characterization procedures: SSIR Sl, rev. 1972, rev. 1984; ASA Mono. #9 1965, 1982 and ASTM Part 19, 1980. (Separate report attached).

Continued analyses of soils for the laboratory comparison project: CEC by NH<sub>4</sub>OAC (pH 7.01, NaOAC (pH 8.2) and Sum of Cations by extractable cations + exchange acidity; extractable cations by NH<sub>4</sub>OAC, PSA by pipette (some by hydrometer).

#### Recommendations

- 1. Future changes in procedures should occur after a review by Committee II and its equivalent in other regions (or establish one national lab committee). When changes do occur send correlation data relating old and new methods.
- 2. Review the use of  $NH_4$  as the ion of choice for exchange work in light of the criticisms of its use in the literature.
- 3. Review the use of isopropyl alcohol as an alternative to ethanol for washing excess NH<sub>4</sub>OAC from soil.
- 4. Review Wada's method for determining particle size distribution on soils such as Andepts.
- 5. Review the methods of Hendershot and Duquette, **Polemio** and **Rhoades**, and **Gillman** as possible alternative methods of determining the exchange properties of soil.

- 6. Retain the SSIR #1 rev. 1972 as well as rev. 1984 as official methods of soil characterization analyses.
- 7. Retain current membership and chair.

#### Special Request

The university representatives from the Southern Region requested the Western Region university representatives to adapt the following resolution.

#### Southern Resolution

"Adapt the  $SSIR\ \#1$  and updates as the official methods and procedures for the characterization of soils in the Southern Region with the exception of soil mineralogy."

The above resolution was assigned to Committee II. Following a discussion, the resolution was accepted by a plurality of the members with reservations as noted in Recommendation 1 thru 5 on page 1.

#### Proposed Western Resolution

TO adapt the SSIR #1 and updates as the official methods and procedures for the characterization of soils in the Western Region with Recommendations 1 thru 5 on page 1 as noted.

#### Conference Requests

Review "Principles and Procedures for using Soil Survey Laboratory Data" NSSL 1984.

# Minutes of Committee II Application of Laboratory Methods June 23 - 24, 1986

The committee reviewed and approved the corrected draft report to the steering committee on the methods used in the ASTM Part 19, 1980, ASA Mono. 9 1965 and 1982 and SSIR #1 rev. 1972 and rev. 1984.

The committee **also** reviewed the **analyses** submitted by various laboratories. Those researchers who were unable to attend were contacted prior to the meeting to determine their status. All researchers contacted intend to complete their analyses in 1986.

Future projects such as the methods comparison project should enlist one laboratory to select and distribute all soil thus avoiding the problems we have encountered during this project. Further, the committee felt that the Lincoln Lab should be asked to provide reference samples for future lab evaluations.

Our committee goal is to complete all of the analyses during 1986. To assist in this goal the chair has been requested to redistribute only those procedures actually needed. In addition, the committee requests that each participating lab return to the chair a detailed explanation of their procedure. Further, the committee felt an attempt should be made to identify the sources of variations encountered in the analyses.

Dispersion problems exist in some of the test soils. One possible source of the problem appears to be gypsum. Another problem appears in the Andepts. Dr. Ikawa has proposed that we evaluate the procedure developed by Dr. Wada to determine particle size distribution of soil such as Andepts (approved by the committee). The ASTM continues to use the hydrometer (Day) for particle size analysis. (Dr. Southard's results with the hydrometer are well within the range of analyses found by the pipette method). The chair will distribute the information from Dr. Ikawa and Dr. Southard as soon as it is received.

Analyses such as CEC have given some committee members problems. Exchange acidity appears to be most variable with California reporting the most difficulties in the procedure ie. poor replication.

California reported that in the  $NH_4OAC$  pH 7.0 method of CEC 100 mL of ethanol was not sufficient to remove excess  $NH_4OAC$  while the use qf Nessler's reagent (150 mL ethanol) appeared to result in loss of  $NH_4$ . Use of isopropyl alcohol has been suggested as an alternative method of removing excess  $NH_4OAC$ .

In further business the chair requested and **Was** supported by the Committee in seeking an additional term as chair.

As a final item of business the committee was asked to support and recommend to the conference the adaptation of the following resolution from the Southern Region.

"Adapt the SSIR #1 and updates as the official methods and procedures for the characterization of soils in the Southern Region with the exception of soil mineralogy".

There was lively discussion on this issue with the majority supporting the proposal. The minority opinion held that the action was premature in light of our studies and other problems. Therefore the group suggests the following stipulations be attached.

- a. Consider alternate dispersion methods for PSA.
- **b.** New methods developed by NSSL should be reviewed by the Regional Lab Committees before adaption and the correlation between the old and new methods should be provided to all researchers.
- c. Additional methods should be explored for determining exchange properties of soils that eliminate the problems outlined on page 1 (see methods of Hendershot and Duquette, Plemio and Rhodes, and Gillman)

Further questions arose.

- a. Is SSIR #1 to be included in the ASTM as currently written?
- b. What process will be used to make changes to the procedures once the SSIR #1 becomes the "official methods" and who will evaluate changes once accepted by ASTM?
- c. Are there acceptable alternatives to ASTM?

#### Western Regional Work Planning Conference of the National Cooperative Soil Survey Portland, Oregon June 23-27, 1986

Report of the Laboratory Methods Subcommittee to the Steering Committee

#### Review of charge (continued from 1982)

- 1. Review current methods of soil analysis with respect to their effectiveness in identifying soil properties.
- 2. Evaluate new methods of soil apalysis and make recommendations to the Western Regional Work Planning Conference.
- 3. Communication problems and solutions to problems encountered in soil characterization analyses.
- 4. Establish minimum standards for laboratory procedures.

#### Additional Recommendations

- 1. Review selected literature and compare analytical procedures. Report findings to the steering committee.
- 2. Exchanges soils with cooperating agencies and determines the variability.

#### Response

- 1. Three types of analytical procedures were selected for review: extractable cations, cation exchange capactiy and texture (pipette for clay). There are several popular ways to analyze for cation exchange capactiy. The selected methods were sodium acetate pH 8.2, ammonium acetate pH 7.0, and sum of cations (extractable cations + exchange acidity by barium chloride pH 8.2). See appendix (1).
- 2. Soil samples were solicited from more than 40 locations. Early on, twenty four researchers indicated interest in the project. We are fortunate to have fifteen researchers currently interested in the project and eight active. Progress has been slower than expected. The Southern and Eastern participants have indicated

their willingness to complete the work before the end of this year. Data received from the various laboratories is reported in appendix (2).

3. The remainder of the charges and recommendations must be considered during the next two years.

#### Literature to Review

Procedures for physical and chemical analyses applicable to soils are available from many sources. This report will review the publications distributed by the Soil Conservation Service (SCS), the American Society of Agronomy (ASA) and the American Society for Testing and Materials (ASTM).

The SCS  $\bullet$  National Soil Survey Laboratory publishes the SSIR #1 which lists their procedures for soil analyses. Their revised edition (1984) contains modifications which reflect procedure automation.

Number 9 in the series Agronomy, (1965) published by the American Society of Agronomy provides detailed procedures for soil analyses. This series has been revised (Part 2, 1982) with some significant changes in cation exchange capacity.

The American Society for testing Materials (1980) provides analytical procedures for a variety of physical tests related to soil analyses used by the SCS and other soil laboratories they also list some chemical procedures for peat materials.

The Official Methods of Analysis of the Association of Official Analytical Chemists (1980) was reviewed as requested but it does not list methods of analysis for soils.

### APPENDIX I

#### Methods of Analysis

SCS ASA ASTM

USDA SCS SSIR #1 Agronomy Series #9 ASTM Part #19

1972 1965 1980

\*\*\*\*\* Extractable Cations \*\*\*\*

Ammonium Saturation
5Ala-Peech (1947

1N NH<sub>4</sub>OAc pH 7.0

Ammonium Saturation
H. D. Chapman
1N NH<sub>4</sub>OAc pH 7.0

5B1, SSIR #1 (1972) 58-2, Bray & Willhite (1929)

revised 1984 revised 1982

\*\*\*\* Extactable Acidity \*\*\*\*

1972 1965

BaCl<sub>2</sub>-TEA I Exchangeable Acidity pH 8.2 BaCl<sub>2</sub>-TEA pH 8.0 6H1, Peech (1947) 59-3, Peech (1962)

KC1-TEA 6H3a, North-Central Regional Research Committee (1955)

revised 1984 revised 1982

BaCl<sub>2</sub>-TEA IV pH 8.2
Automatic Extractor
6H5, Peech (1947)
Barium Chloride-TEA Method
BaCl<sub>2</sub>-TEA pH 8.2
9-4.1, Thomas (1982)

Potassium Chloride Method IN KC1/1N KF 9-4.2, Thomas (1982)

水水が水 Cation Exchange Capacity かかかか

1972 1965

Amonnium Saturation
Distillation
IN NH<sub>4</sub>OAcpH 7.0
5A1, Peech (1947)
Ammonium Saturation
Distillation
IN NH<sub>4</sub>OAcpH 7.0
57-2, Chapman (1965)

SCS ASA ASTH

Sodium Saturation Centrifuge method 1N NaOAc pH 8.2 5A2, Richards (1954)

Sum of Cations Exc. Acidity by BaCl<sub>2</sub>-TEA pH 8.2 + Sum of extr. bases 5A3a, Peech (1947)

BaC12, pH 8.2 Mg(NO<sub>3</sub>)<sub>2</sub> 5A5, SSIR #1(1972)

revised 1984

Ammonium Acetate Ditillation Automatic Extractor IN NH<sub>4</sub>0Ac pH 7.0 5A8, Holgren (1977)

Ammonium Chloride Distillation Automatic Extractor 1N NH<sub>4</sub>Cl 5A9, SSIR #1 (1984)

Sodium Saturation Centrifuge method 1N NaOAc pH 8.2 57-3, Chapman (1965)

Summation
Exc. Acidity by
BaCl<sub>2</sub>-TEA pH 6.0 +
Sum of extr. bases
57-4, H.D. Chapman
(1965)

revised 1982

Sodium Acetate Arid Lands Centrifuge 0.4 N NaOAc/MgNO<sub>3</sub> in 60% ETOH 8-3, Polemio& Rhodes (1977)

Barium Chloride Acid Soils-tropical Centrifuge 0.1 MBaCl<sub>2</sub>/MgSO<sub>4</sub> 8-4, Gillman (1979)

1972

Pipette Method 3A1,

\*\*\*\* Reaction \*\*\*\*

SCS <u>ASA</u>

\*\*\*\*\* Bulk Density \*\*\*\*\*

#### The Differences

#### **Extractable Cations**

The most commonly recommended analytical proceudre for extractable cations is the ammonium acetate method. A minor modification of this method is the use of the centrifuge as an additional recommended means of separating the extracting reagent from the soil. An automatic extractor has been introduced by the National Soil Survey Laboratory as the method of choice in the revised 1984 SSIR #1. Finally, the barium method has become an additional means of obtaining the extractable bases as well as the extractable acidity (Quick and Rible, 1960; Hendershot and Duquette, 1986; Singer and Janitzky, 1986). As a reminder, exchangeable cations are obtained by subtracting the water soluble cations from the extractable cations.

#### Cation Exchange Capacity

Ammonium acetate, sodium acetate, the sum of cations (the sum of the extractable bases and the exchange acidity by BaCl<sub>2</sub>-TEA or KCl) have been popular methods for determining cation exchange capacity. The Soil Conservation Service – National Soil Survey Laboratory modified the existing procedures by introduction of the automatic extractor for extractable cations and exchange capacity in the revised 1984 SSIR #1.

The most significant change in the sodium acetate method is outlined in the revised 1982 Agronomy series #9. Rhoades suggested the method of Polemio and Rhoades (1977) for arid soils as well as for nontropical acid soils: pH 8.2, 0.4N NaOAc-0.1N NaCl. Rhoades further recommended the procedure of Gillman (1979) for tropical acid soils (soils high in iron oxide). A solution of BaCl2 at low concentration (See also the publication by Hendershot and Duquette for a modification of Gillman's method) A further measure of the exchange capacity of the soil is obtained with KC1 which is used to determine extractable (exchangeable) aluminum (Thomas, 1982). Pratt and Bair consider exchangeable aluminum accounts for most of the exchange acidity in the soil. The sum of cations (summation) method adds the exchangeable bases and exchange acidity to obtain the cation exchange capacity. Earlier procedures for exchange acidity used a lower pH (8.0) in their buffer solution (Peech, 1962).

#### Particle Size Analysis

The methods of analysis for particle size have remained constant for years. The Soil Conservation Service uses the pipette method for clay determination when soil characterization data is desired and the hydrometer is used in the field offices for calibration purposes. Total sand can be determined by wet and dry sieving. The sieves are ASTM #18 (1mm), 35 (0.5mm), 60 (250 $\mu$ m), 140 (106 $\mu$ m), and 300 (47  $\mu$ m). Where appropriate, H<sup>2</sup>O<sup>2</sup> is used as a pre-treatment to remove organic matter. Use of sodium acetate to remove calcium carbonate is

Excess salts are removed. Dispersion is accomplished by shaking in sodium hexametaphosphate overnight on a reciprocating (SSIR #1) The American Society for Testing and Materials shaker. (ASTM) continues to use the hydrometer method for particle size analysis (Part 19, 1980 D 422-63 reapproved 1972). Corrections for hydrometer and cylinder variation are applied as well as for the temperature (Use of a summation curve allows one to determine the 2' micron clay at the appropriate time). The ASTM uses the following sieves in their sand analysis: ASTM #10(2mm), 20(850  $\mu$ m), 40(425  $\mu$ m), 60(250μm), 140(106μm), and 200(75μm). No pretreatment is recommended. The soil is dispersed with sodium hexametaphosphate "sing the air-jet dispersion cup or the "malt mixer" dispersion cup. The ASTM uses a" insulated water bath to maintain constant temperature in the hydrometer cylinders during the test.

Some questions need to be answered. Why does the ammonium ion continue to be used as the ion of choice for cation exchange capactiy and extractalbe cations when several researchers have indicated that the ammonium ion, due to its similarity to potassium (Sawhney et al., 1959), can be fixed, blocking the removal of itself or other ions? Why does ethanol continue to be used as a means of washing the excess ammonium acetate from the soil when it has been shown by Carlson (1962) to remove adsorbed ammonium ion from the soil. Carlson as well as Chapman have recommended the use of ispropyl alcohol.

#### Literature Cited

- American Society for Testing and Materials. 1958. Procedures for Testing Soils, Am. Soc. Testing Hater. Cited by G. R. Blake in C. A. Black et al. (eds.) Methods of Soil Analysis. Agronomy Mono. 9:371-390. Am. Soc. Agron., Inc. Madison, Wis.
- Mono. 9:371-390. Am. Soc. Agron., Inc. Madison, Wis.

  Annual Book of ASTM Standards. 1980. Part 19. Soil and Rock: Building stones. A. Soc. Testing and Materials, Philadelphia, Pa.
- Black, C. A. et al. (eds.) 1965. Methods of Soil Analysis. Part 1. Agronomy Mono. 9. Am. Soc. Agron., Inc. Madision. Wis.
- Black, C. A. et al. (eds.) 1965. Methods of Soil Analysis. Part 2. Agronomy Mono. 9. Am. Soc. Agron., Inc. Madision, Wis.
- Blake, G. R. 1965. Particle Density. In C. A. Black et al. (eds.) Methods of Soil Analysis. Agronomy Mono. 9:371-390. Am. Soc. of Agron., Inc. Madison Wis.
- Bray, R. H. and F. N. Willhite. 1929. Determination of total replaceable bases in soils. Cited by Chapman in C. A. Black et al. (eds.) Methods of Soil Analyses. Agronomy Mono. 9:902-904. Am. Soc. of Agron., Inc. Madison Wis.
- Carlson, R. M. 1962. A study of some aspects of cation exchange in soils. Ph.D. dissertation. University of California, Berkeley.
- Chapman, H. D. 1965. Cation Exchange Capacity. In C. A. Black et al. (eds.) Hethods of Soil Analysis. Agronomy Mono. 9:851-901. Am. Sac. of Agron., Inc. Madison Wis.
- Day, P. R. 1965. Particle fractionation and particle size analysis. In C. A. Black et al. (eds.) Hethods of Soil Analysis. 2nd ed. Part 2 Agronomy Mono. 9:545-567. Am. Soc. of Agron., Inc. Madison Wis.
- Hendershot, W. H. and M. Duquette. 1986. A simple barium chloride method for determining cation exchange capacity and exchangeable cations. Soil Sci. Soc. Am. J. 50:605-608.
- Holmgren, G. S., R. L. Juve and R. C. Geschwnder. 1977. A
   mechanically controlled variable rate leaching device. Cited in
   SSIR No. 1, Rev. 1984.
- Kilmer, V. J. and L. T. Alexander. 1949. Methods of making mechanical analyses of soils. Cited by P. R. Day in C. A. Black et al. (eds.) Methods of Soil Analysis. Agronomy Mono. 9:545-567. Am. Soc. of Agron., inc. Madison Wis.
- North-Central Regional Research Committee on Soils (1955). Cited in SSIR No. 1, Rev. 1972.
- Page, A. P. et al. (eds.) Methods of Soil Analysis. 2nd ed. Part 2. Agronomy Mono. 9 Am. Soc. of Agron., Inc. Madison Wis.
- Peech, M., L. T. Alexander, L. A. Dean and J. F. Reed. 1947. Methods of soil fertility investigation. Cited in SSIR No. 1, rev. 1984.
- Peech, M., R. L. Cowan and J. **H. Baker.** 1962. A critical study of the barium chloride-triethanolamine and ammonium acetate methods for determining the exchangeable hydrogen content of soil. Cited by M. Peech in C. A. Black et al. (eds.) Methods of Soil Analysis. **Agronomy Mono.** 9:910-912. Am. Soc. of Agron., Inc. Madison, Wis.
- Peech, M. 1965. Hydrogen-ion Activity. In C. A. Black et al. (eds.) Methods of Soil Analysis. Agronomy Mono. 9:914-926 Am. Soc. of Agron., Inc. Madison Wis.

- Polemio, M. and J. D. Rhoades. 1977. Determining cation exchange capacity. Cited by J. D. Rhoades in A. L. Page et al. (eds.)
  Methods of Soil Analysis. 2nd ed. Part 2. Agronomy Mono.
  9:914-926 Am. Soc. of Agrono., Inc. Madison Wis.
- Pratt, P. F. and F. L. Blair. 1962. Cation exchange properties of some acid soils. Hilgardia 33(13), University of California Berkeley, CA.
- Quick, J. M. and J. M. Ribie, 1960. Laboratory **Methods** for Soil Plant and Water. Agr. Extension Service University of California, Davis, CA.
- Richards, L. A. ed. 1954. Diagnosis and improvement of saline and alkali soils. Cited in **SSIR** No. 1, rev. 1972.
- Rhoades, J. D. 1982. Cation Exchange Capacity. In A. L. Page et al. (eds.) Methods of Soil Analysis. 2nd ed. Part 2 Agronomy Mono. 9:149-157. Am. Soc. of Agron., inc. Madison Wis.
- Sawhney, B. L., M. L. Jackson and R. B. Corey. 1959. Determination of soils as influenced by the cation species. Soil Sci. 87:243-248.
- Singer, M. J. and P. Janitzky ed. 1986. Field and laboratory procedures used in a soil chronosequence study. US Geological Survey Bulletin 1648.
- Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples. rev 1972 Soil Survey Investigation Report No. 1. Soil Conservation Service, US Dept of Agr. Washington.
- Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples. **rev** 1984. Soil Survey Investigation Report No. 1. Soil Conservation Service, US Dept of Agr. Washington.
- Thomas, C. W. 1982. Exchangeable Cations. In A. L. Page et al. (eds.) Methods of Soil Analysis. 2nd ed. Part 2. Agronomy Mono. 9:154-157. Am. Soc. of Agron., Inc. Madison Wis.
- Tyler, E. H. 1940. The use of sodium metaphosphate for dispersion of soil for mechanical analysis. Cited by P. R. Day in C. A. Black et al. (eds.) Methods of Soil Analysis. Agronomy Mono. 9:914-926 Am. Soc. of Agron., Inc. Madison Wis.

### APPENDIX II

Laborator	y Ana	rative Soil lysis Sub Co mparison of (	mmittee	Cat Tex	ture		
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 National Cooperative Soil Survey
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Committee members and Expiration Date

1988 - Bob Meurisse, FS, Oregon, Chairman

1988 - Jim McLoughlin, BLM, NV

1987 - John Rogers, SCS, CA

1987 - John Cipra, Colo, State Univ.

1986 - Shelby Brownfield, State of Id.

1986 - Herb Huddleston, Oregon State Univ. Jerry Latshaw, SCS, OR

Charges for the Committee:

- (1) Review and comment on new soil interpretation criteria.
- (2) Encourage development of new interpretation as need.
- (3) Encourage or promote the testing of existing criteria.

Activities since last report (May 1984). Committee members reviewed the proposed changes for the National Interpretations Record Committee. Most were in general agreement with added soil properties, but had some recommendations for further consideration. Specific comments were given for each of the three proposed interpretations, i.e., tillage, fencing, unsurfaced roads.

For example, (1) some concern was expressed about Ecological Site or Range site and Potential Plant Communities. This needs further work. (2) Volume for common trees and trees to plant are being proposed in metric units. Members suggest <code>english</code> units would be better. Also, reference age for site index needs to be specified.

There is general agreement with the proposal to have separate pages for soil properties, agronomic interpretations, forestry. range, and wildlife and windbreaks.

#### Recommendations:

1. This committee could serve as a clearing house for the WNTC or Regional Conference for comments on proposed interpretations. That is, it could represent the West Region point-of-view.

Specific to this is that the committee could look at properties influencing plant communities and could assign the issue to the States with appropriate expertise.

2. Need to look at formating and displaying soil survey information. Get volunteers to try new formats. Communication of interpretations is key to our work.

- 3. There nerds to be a better mechanism for ensuring that there is follow-up to recommendations made. This committee could be a facilitator for that process.
- 4. Local committees could be appointed, perhaps by this committee, early in the survey to review interpretations. This can be unwieldy and might be more easily handled by each responsible agency in a State to provide for review.
- 5. Determine issues needing most attention. Needs a close tie to research needs committee. Two particular items were emphasized:
- a. Soil erosion and effects on productivity and consistency  ${\bf in}$  "se of parameters for erosion.
- h. Impacts from  ${\tt management}$  , especially changes in productivity (yields) from soil compaction and burning on Forest soils.

## 501-Standing Committee-Research Priorities

#### Committee Members:

1988 D. Hendricks, University of Arizona, Chairman 1988 B. Thomas, BLM, Oregon 1987 H. Sato, SCS, Hawaii 1987 L. Daugherty, New Mexico State University 1986 J. Collins, FS, Utah 1986 C. Montague, Montague State University

D. Dierking, SCS, WNIC, Oregcm

#### Committee Charge:

Determine research priorities for NCSS--include soil survey and their application or interpretations. **Consider** effects of practices on long-term productivity for agriculture, range and forestry. Report priority **needs** at each conference.

#### Recommendations:

A. Soil climate number one priority need

The 1984 Western Regional Cooperative Soil Survey Conference held in El Faso established soil climate (soil-temperature and soil moisture) and its relation to vegetation as the first priority research need. The current standing committee on research priorities considers this area to be a continuing need and to again be considered the number one priority research need.

It is now recognized that the definitions and applications of the parameters used to characterize soil climate in <u>Soil Taxonomy</u> have a number of shortcomings. This is particularly true in the western United States where much of the land is used for range, forest, and other noragronomic purposes. The following arc suggested areas that need to be evaluated:

- Soil moisture control section: The soil moisture control section as defined is logical in that it takes into account differences in permeability, moisture retention, and other hydrologic properties between soils. Although the actual in situ measurement of the soil moisture control section is not easy to make and apparently is rarely made, it can be estimated from soil characterization data. Some people have criticized the definition as not being relevant to shallow moted plants such as some raid range grasses or to deep-rooted tree rooted plants such as semi-arid range grasses or to deep-rooted tree
- Methods of measurement: Generally the measurement of soil temperature is relatively straight forward and offers few difficulties. The measurement of soil moisture on the other hand presents problems. The two common methods of monitoring soil moisture are the neutron probe and the use of gypsum blocks. The former is not suitable for soils with coarse fragments. The latter technique requires careful calibration of the individual gypsum blocks.
- Indirect methods: It is highly desirable to develop and apply indirect methods to extrapolate to areas where soil climate data are lacking. One approach is to use models on which climate data (precipitation and air temperature) and site characteristics (slope,

aspect elevation, soil properties, etc.) are used to estimate the soil moisture and soil temperature regimes. The Newhall method is one example that uses climate data and has been quite useful.

The second of the Arms of the State of Section (1998)

A second indirect method is the use of indicator plant species. If a particular species can be established as being adapted to and restricted to a certain soil climate then its presence and distribution can be used as an indication of the occurrence of that particular soil climate. This technique has been applied to some extent in soil survey in a number of areas. The actual relationship between the species and the soil climate is generally inferred with little, if any, data to relate the two.

- 4. Definitions of soil moisture and temperature regimes: The soil moisture regimes reflect the amounts and annual distributions of precipitation or in the case of the aquic moisture regimedrainage conditions. The soil temperature regimes generally are related to the temperatures. Some people consider that the soil moisture and temperature regimes as now defined as not completely satisfactory.
- B. Soil erosion a high priority.

The committee also considers soil erosion to be an area of high priority. The importance of soil erosion is recognized since a national soil survey laboratory has been established and the USDA ARS is actively engaged in research in this area. The committee identifies the following of importance relative to soil erosion:

- Prediction of erosion rates under different management systems:
   Better ways of defining erosion hazard for various land uses, cover,
   and climate are needed. This is especially true in large units of
   "wildlards."
- 2. Effect of erosion on productivity: More quantitative relationships between declines in yield (timber, grass, or **food) and** a **given** loss of soil material by erosion is **needed**.
- Methods of measurement: Our inability to statistically measure erosion, particularly in large areas of "wildlands" is another area of need.
- 4. Internal and external costs: In addition to the "on site" costs of erosion relative to soil losses more emphasis should be placed on the fate of the removed material. The removed particulate matter provides a source of sediment that can clog or fill up drainage ditches, waterways, etc. Nonparticulate matter or substances sorted on soil particle such as pesticides, herbicides, and fertilizers when removed by erosion present potential pollution hazards.
- **C.** Soil variability a high priority.

The committee considers soil variability to be a third research priority area. The subject is addressed by another conference committee and is described in detail by that committee's report. The following are identified as subjects of additional or continual research need:

- Variability of components in a mapping unit.
- 2. Variability of a single component of a mapping unit.
- 3. Application of geostatistics.

D. Other important areas of research.

A number of additional research areas are identified as important even though they do not have as high a priority as those listed above. Continued research in these areas is extremely important for the advancement of soil science. These areas include the following:

- 1. Application of remote sensing technology to soil survey: the conventional use of remote sensing data (i.e. aerial photographs) has been invaluable in the soil survey program and will continue to be used. Recent advances in remote sensing technology has led to an increased interest in its use or potential use as an aid in the mapping of natural resources, including soils. Another conference committee has addressed this topic in detail.
- Develop improved methods of characterizing soils: Determining and characterizing soil properties (chemical, physical, mineralogical. and micromorphological) is extremely important to all aspects of soil science, as well as for soil survey activities. Ideally, we should have uniform and standard methods to measure soil properties that are universally applicable to all soils. Unfortunately, soils being what they are, this is often not attainable. for example, analytical techningues vich are applicable to most soils may be unsatisfactory for Andisols or for Gypsiorthids.
- 3. Soil genesis: There is a continual need to better understand the processes that lead to the formation of different soil features, especially the diagnostic features. In many of our soils, particularly the older soils, relic features are present that reflect soil forming conditions of the past. We need to evaluate these features and conditions more fully.

A greater understanding of the relationship between soils and climate vegetation, parent material, geomorphic surfaces, and time is needed. Jenny's approach of functionally relating soil properties to the soil forming factors has been invaluable in improving our understanding of the natural distribution of soils. Additional work needs to be done. We need to develop a landscape ecology perspective for soil science in whichwedocumentandquantifythe role of soils inecosystems. We need to evaluate material fluxs in ecosystems and develop holistic ecosystem models. Further study of soil development in relation to geomorphic processes, especially in western semi-arid regions is needed.

4. Improve Soil Taxonomy: As soil surveys expand into new areas with new soils being encountered and as basic research extends our knowledge about soils there is a continual need to refine and modifyour soil classification system. Accompanying this is the need to provide additional data to better characterize key soils and to show their relationships to other soils both in a taxonomic framework and in their field setting.



Research Branch Direction générale de la recherche Land Resource Research Centre
Centre de recherche sur les terres
Central Experimental Farm
Ferme Repérmental

Your file Votre référence

Our Ne Noire référence

Dr. Richard R. Kover
Head, Soils Staff
USDA Soil Conservation Service
West National Technical Centre
511 N.W. Broadway, Room 547
Portland,
Oregon 97209-3489
U.S.A.

pp WHowe

## **Canadä**

## Soil Survey in Canada: 1985

#### Keith Valentine\*

Thank you very much for the invitation to attend your conference. I first attended one of these meetings in **San** Diego in 1978, and it is **a** pleasure to meet some of you again. Today I would like to tell you briefly of what is facing us in **Canadian** soil survey, and of some of the modifications to our programs that we may be making **in** the future.

Soil Survey in Canada, as in the U.S.A, is a co-operative effort. In addition to the Federal Government survey units of Agriculture Canada located in each province, the provinces themselves have their own survey organizations. In s "umber of instances both groups are located on the campus of a University with a Soil Science Department, and all three are linked as a" "Institute of Pedology". This arrangement has worked very well for us, the Federal Government, as it keeps us in close touch with what the provinces need. Through such combined efforts since the early 1920s we have soil maps at various scales for the whole of the agricultural portion of Canada, and for perhaps two thirds of the rest. There are also, of course, private companies doing soil survey; usually at large scales to answer particular land "se questions. Thus the picture in Canada is one of active inventory by many organizations at various scales. This is exciting, but presents a real challenge for correlation and quality control.

However, this picture is changing, especially for us in the Federal Government. Our budgets are being reduced, and we are being told to **concentrate** on those things that a national **inventory** organization can do best. Many of the potential changes we have been **considering** for some time anyway, and I would like to mention a few today.

Standard Inventory: We are beginning to "contract out" larger scale surveys to private companies. Our role will be to establish procedures, standards, and, if required, check and correlate the final work. Detailed arrangements have yet to be worked out, but we will probably not give up mapping altogether. The feeling is that we have to be doing at least some survey to retain credibility in supervising it. However, we will be spending more time on specifying field procedures, and developing methods of checking mapping accuracy.

"National" Inventory; Soil Landscape Mapping and Data Base: A" obvious task for us is the compilation of a map of soil and land features for the whole country. The data should be consistent and complete. Of course, in a sense this is the fundamental raison d'être of soil survey. But in reality the aggregation of our traditional surveys is not giving us this. Procedures have changed through the years, data is not consistent and scales have varied tremendously. Moreover, budgets are no longer certain enough to plan

<sup>\*</sup> Head, Soil Inventory Section, Land Resource Research **Centre**, Agriculture Canada, Ottaws, Canada, **KIA** 0C6. A <u>summary</u> of a talk given to the Western Regional Co operative Soil Survey Conference, Portland, Oregon 23-26, June 1986.

"national coverage" over future decades. Therefore we have draw" back to a project that we believe we cs" accomplish in say five years. This is a map end data base at a scale of 1:1 million. Further, 1t is a descriptive mapping program whereby each msp delination, or polygon, is described by a standard list of attributes. No map units are created. The classification aspect of mapping is minimized. Each delineation bears a "umber and a string of attributes. This has the advantage that the data structure is very simple for a computer to handle. It is also very essy to combine those data with others, such as climate or census, for land evaluation purposes. so far we have compiled such data for the agricultural portion of the country and have produced interpretive maps for such things as wind erosion risk and susceptibility to acidification.

National Soil Information System; CanSIS: CanSIS has been based on our own software developed in-house, Fifteen years ago when we started there was no alternative. But now we find our software incompatible with commerical geographic information systems being used by other agencies. Exchanging information is difficult. Therefore we plan to buy the commercial ABC/INFO geographic information system software, and acquire our own dedicated computer to run it. In addition we are beginning to reorganize the structure and content of the information in CanSIS. The emphasis will be on information relevant to crop growth and correlation. What is more we will restrict ourselves to that amount of data that we are sure we can handle, I personally believe soil geographic information systems must stop trying to be all things to all me".

Monitoring Soil Quality: Monitoring is one of those catch words that happen to be current right now. To us it means enquiring into whether, and If so how, soil properties are changing with time. It has come into special vogue related to soil degradation research, and it appears to me that an inventory organization can play s" important role here. If soil Inventory is taken to be a study of soil variability then it can have two parts; mapping variability in space, and monitoring variability in time. The connection with "Soil Quality" comes from our degradation studies. We are doing considerable work on degradation and conservation; including extent, processes and amelioration. Coupled with this must be work to define soil quality (so we can reorganize a non-degraded soil when we see it); and work to determine to what extent our soils are deviating from that quality with time.

These are some of the principal challenges that face us in the "ear future. There is no doubt our work will be changing. In essence we will be doing less mapping, less data gathering, and more interpretation or assessment of soil information and more work on procedures and methods. For all of this we look forward to continued cooperation with your Cooperative Soil survey. We have found such cooperation extremely valuable in the past, and I think with some of these new directions we are going to need all the help we can get.

# FUTURE OF THE NATIONAL COOPERATIVE SOIL SURVEY West Technical Soil Survey Work Planning Conference June 23-27, 1986

Peter E. Avers
National Soils Program Leader
U.S. Forest Service
Washington, DC

The Forest Service (FS) has enjoyed a long productive relationship with the Soil Conservation Service (SCS) in the National Cooperative Soil Survey (NCSS), spanning some 28 years. Many FS Soil Scientists have participated in excellent training programs sponsored by SCS; numerous soil survey reports of national Forest lands have been published through the NCSS; and there are many established efforts where ideas, data, and formation is shared. Policy issues and areas of technical differences have surfaced occasionally but these are dealt with to strengthen the NCSS effort.

The FS has never had a greater need for soils information than now as we begin to implement our canprehensive Forest Plans. The Forest Lard Management Planning (FLMP) effort was generated by the National Forest Management Act of 1976, which requires, among other things, that management be in accordance with land capability and that soil productivity be maintained. In many instances, we do not have adequate inventories to provide soil interpretations on suitability, productivity, limitations, and hazards. The FS need for more soils information puts added importance to participation as a partner in the NCSS. However, traditional data handling and publication methods may no longer be appropriate to meet information needs. We need to examine closely how we are doing sane things and make necessary changes to strengthen the cooperative effort. Future involvement of the FS in the NCSS will depend upon more effecient delivery of cost effective soils information.

The FS and SCS have a mutual goal to complete the once-over soil survey by the year 2000 and include the data in NCSS publications. What is the status of this goal for National Forest (NF) Lands? Only about 20 percent of NF lands are published in the NCSS. However, batter than 40 percent has been correlated. We have a long way to go to include all NF lands in the NCSS. A cursory analysis of budgets for the next few years indicates it is not likely we'll make much progress unless we cane up with new approaches. The FS has about 90 percent of NF lands covered with in-service soil inventories that do not meet current standards, but are used for broad land management planning. We have other problems that will make it difficult to achieve our mutual goal. For instance, we have millions of acres of surveys that meet standards, but because of changes in direction, no longer provide management useful information and are outdated. Also, there is a perception many of our managers have that the once-over is not as important when the Forest Plan is canplete. What they want is detailed information for projects to implement the Forest Plans. There is a recognized need to finish the once-over; but it is low priority in several Regions for the near future.

Evaluations are being made on the effects of reduced soil inventory budgets and reductions in soil scientist manpower. The FS budget for Soil Inventory is over \$6 million for FY86, but is projected to be between \$3.4 and \$4.0 million for FY88. The number of soil scientists is currently about 210, down from over 300 Another interesting fact is that less than 20 percent of current FS Soil Scientists are engaged in progressive soil surveys. Many inventories are being conducted by interagency agreements and private contractors. Host Regions have not hired trainee soil scientists for five or six years. Furthermore, our line managers are continuing to consolidate duties and/or share soil scientists Current duties are soil management support services, planning, between Forests. monitoring, training others in using soils information, preparing guielines, and administering agreements and contracts for mapping. The idea at this time is to provide soils information needed to meet current management concerns, issues, Soil inventory for the next round of Forest Planning, while viewed as needed, is not a high priority item. This support is a reflection of tight budgets, but also could be an indication that we haven't done a very good job of presenting or demonstrating usefulness of soil inventories.

Improvements are needed in several areas of FS involvement in the NCSS so that soil inventories are conducted more effeciently and effectively.

- 1. Agencies need to work together in a truly cooperative spirit in solving map unit design, classification, and correlation differences. These problems can unnecessarily drain energy and funds fran more productive efforts.
- 2. Manuscripts and interpretations need to be prepared for maximum utility by land managers in the FS. This requires departure from standard format.
- 3. Memorandums of Understanding should spell out clearly the Agency responsibilities. This will help managers and foster mutual goals. Key items to cover with specifications are publication format, correlation of families, and filling out forms 5 and 6.
- 4. Mapping and quality control techniques need to be improved to aid field work, increase mapping productivity, and improve reliability.
- 5. It needs to be determined what soil data from the National Forests is needed for the national soils data base. For instance, there are no plans to include data from in-service soil survey areas that will not be published as Soil Survey Bullet:

The future involvement of the FS in the NCSS looks very positive where we can clearly identify mutual benefits. Our Regions are evaluating their soil inventory status. Areas without any coverage and areas identified in Forest Plans for intensive management will be priority areas for new surveys. Older surveys that were never correlated will probably remain that way until they are rescheduled for a new survey. This means that several millions of acres will not be scheduled for a correlated survey for perhaps a decade or more. Managers will continue using the existing information for general planning and request more detailed information on fragile or intensively used lands.

Progress has been made on adjusting publication format primarily for woodland tables and mapping unit descriptions. This will improve the usefulness of NCSS publications for FS land managers. More use of computers in handling manuscripts, soils data, and information can be expected. The FS is moving towards a Geographic Information System (GIS) and this will reduce the need for hard copy soil survey publications in the future.

Soils data available through the NCSS has been helpful in preparing Forest Plans. As plans are implemented, there will be new opportunities for involvement. How successful we are at taking advantage of these opportunities and continue a truly cooperative venture depends on our ability to focus on the needs of users.

#### WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE

June 23-27, 1986

## CARTOGRAPHIC COMMENTS

## A. ORGANIZATION

The Cartographic staff has undergone some changes in organization recently. Following are a few items worth noting:

1. Titles and Responsibilities

W. RICHARD FOLSCHE, Head National Cartographic Center

Responsible for all MCC activities.

DONNEL L. STELLING, Chief NCSS Branch National Cartographic Center

Responsible for overall NCSS operations.

W. L. SIKES, Assistant Chief NCSS Branch

IEMAN SPAN, Section Head
Map Finishing and Negative Prep Section, NCSS Branch
National Cartographic Center

Responsible for preparing map material for printing after map finishing is completed.

HUCH ALLCON, Section Bead Map Finishing and Contract Section, NCSS Branch National Cartographic Center

Responsible for review of map compilation before contracting and other subject matter related to contracting.

VIC McWILLIAMS, Section Head Section B, MCSS Branch National Cartographic Center

Responsible for the production of General Soil Maps and Index to Map Sheets.

#### B. FY-86 PUBLICATION STATUS

Inclosed is a listing of soil surveys for which Map Negatives have been sent to the printer in FY-86.

## C. STATUS OF GENERAL SOIL MAPS AND DETAILED MAPS

Enclosed is a listing of soil surveys for which General Soil Maps or Detailed Maps are in work in Carto as of 06/11/86.

## D. STATUS OF PUBLICATION IMAGERY AND PHOTOBASE MATERIAL

We request that each state soil scientist review this listing and make any changes that you are aware of. The following columns should be checked and updated.

PUB SCALE - Be sure the scale shown agrees with the currentplans in the state.

TYPE OF IMAGERY - Confirm that HA (High Altitude) or OR (Orthophotography) is correct.

FORMAT - Is the format correct?

MAP MATERIAL DUE STATE - Is the date shown correct when material is needed by the state?

If a 99/99 appears, this mans Carto is not aware of a due date in the state.

## E. CARTOGRAPHIC SUPPORT OF SOIL SURVEYS

This three page enclosure gives a brief overview of USGS activities on a nations1 level including the names of soil surveys received for map finishing contracting.

## CARTOGRAPHIC SUPPORT OF SOIL SURVEYS

The National Cartographic Center, Fort Worth, Texas, helps to support the soil survey program as follows:

- (1) Obtaining imagery mapping and publication

- (2) Preparing photobases and related overlays
  (3) Preparing final publication negatives
  (4) Preparing General Soil and Index Maps and block diagrams

In addition to the above, Cartographic sends and retrieves materials from the Federal Record Centers, prints interim copies of map sheets, prepares photographic enlargements of map sheets and prepares duplicate line negatives of soil information.

Cartographic re-entered the arena of contracting for map finishing during FY86. To date we have contracted five jobs. Another four jobs will be contracted by the end of June, 1986. We expect this effort to grow, especially as state budgets are Cut. Two full-time positions are presently working in contract map finishing.

## **Obtaining Imagery**

most of the imagery is obtained from two main sources:

- (1) ASCS, Salt Lake City, UT NHAP-B&W-CIR
- (2) USGS Orthophotography

The average cost of a survey covered by NHAP-B&W-CIR stereo is \$3250.00, Imagery generally will not be ordered until complete county coverage is obtained, because ASCS will not prepare control on partial county coverage. The average turn-around time for NHAP is 2 to 3 months.

USGS orthophotoquads now cost \$60.00 each for reproducibles, \$750.00 each for newly constructed quads.

The average eastern county takes approximately 15 orthogoads. The average western soil survey area takes approximately 60 orthoquads.

The time required to obtain orthophotography ranges from five months (for reproducibles) to three-plus years (for new construction of orthos).

Due to the cost of getting ground control, USGS prefers to work a block of several counties at one time, rather than a single county. We are very dependent on their scheduling.

## Preparing Photobases

This section has the greatest number of workers assigned to it and has produced the greatest number Of jobs of all the sections in the NCSS Branch. Ideally, we would like to have six months from the acquisition of imagery until shipment of photobases to the state,

This year we will have a drop in production from 126 jobs (FY85) to approximately 90 jobs. This is happening because we have worked through a backlog of partially completed jobs which were transferred to Fort Worth during Cartographic consolidation and we are now working with imagery that has recently been acquired. In future years, the photobase production may drop to 50 or 60 jobs per year, depending on imagery acquisition.

## Negative Prep

Production of press negatives for soil survey publication has been the most consistent at approximately 80 jobs per year for the past four years.

Since January, 1984, we have limited the review of final overlays to a **ten** percent sample, and we are calling attention only to soil related errors and quality of linework.

We are still receiving about 90 to 95 jobs **per** year into cartographic for production of final negatives. At present, we have 165 jobs in cartographic to be worked.

The highest priority jobs for negative prep are those that have the text ready. Each month we get an update from Pat looper, NHQ Publications Branch. We work those jobs first which have or will have, according to Looper, the text ready within three months. This coordination allows some jobs to move through cartographic quickly while others remain in cartographic for a much longer period of time. Fifty-nine jobs have been in cartographic over a year, awaiting completion of the text.

Page 3

## CONTRACT MAP FINISHING

The following is a list of jobs that are presently in Cartographic:

Name	No. Sheets	Iow Bid	<u>Cost/Sheet</u>
<ol> <li>Grant &amp; Hardy Cos., WV</li> <li>Guam</li> </ol>	68 15	\$9962 1478	\$147 99
3. Avoyelles Pa., LA	48	8928	186
4. Box Elder, UT	75	9750	130
5. Greensville $\infty$ ., VA	39	6072	156
6. Sullivan Cc., <b>NY</b>	124		
7. Ellsworth co., KS	56		
8. Pangvitch Ar., UT	34		
9. <b>Concordia</b> Pa., <b>LA</b>	45		
10. Gaston Co., NC	8		
11. Williamsburg Co., ${f x}$	76		
12. Orangeburg Co., SC	88		
13. Fremont Ar., WY	274		
14. St. Tammany Pa., LA	72		
15. St. Bernard Pa., LA	81		
16. Tangipahoa Pa., LA	65		
17. Natchitxxhes Pa., LA	104		
18. Dorchester 🗀 SC	55		
19. San Juan Ar., <b>ÙT</b>	78		
20. Allen Co KY	31		

## NCSS PRODUCTION

		EY83	FY84	FY85	FY86 (thru May)
No. of Aerial Surveys Ordered	NHAP - OR -		56 46 102	65 44 109	27 10 37
No. of Photobase Jobs to State		66	147	126	47
No. of Surveys to Printer		78	72	81	41



## NTC NCSS REGIONAL CONFERENCE

June 1986

## SOIL MANAGEMENT SUPPORT SERVICES

PROJECT ACTIVITIES SUMMARY





## INTERNATIONAL SOIL CLASSIFICATION COMMITTEES

June 1986

ICOMLAC -International Committee on Lou Activity Clays

Chairman: Dr. Frank Moormann
Institute of Earth Sciences
University of Utrecht
4, Budapestlaan,
3508 Ta Utrecht
THE NETHERLANDS

ICOMERT International Committee
on Vertisols

Chairmanr Dr. Juan Comerma CENIAP, MAC Apartado 4563 Haracay 2101 VENEZUELA

ICOMAND = International Committee on Andisois

Chairman: Dr. Mike Leamy
Director, Solls Bureau
DSIR
Private Bag, Lower Hutt
NEW ZEALAND

ICOMID International Committee
on Aridisols

Chairman: Dr. A. Osman
Director, SoliScience Division
ACSAD
Damascus
SYRIAN ARAB REPUBLIC

ICOMOX -International Committee on Oxisols

Chairman: Dr. Stan Buol
Dept. of SollScience
North Carolina State
University
P.O. Box 5907
Raleigh, N.C. 27650

ICOMAQ -International Committee on Aquic Solis

Chairmanr Dr. J. Bouma
Soii Survey Institute
Spoorbanweg 35
3911 CA Rhenen
THE NETHERLANDS

ICOMOD -International Committee on Spodosols

Chairmanr Dr. R. V. Rourke
Department of Plant
and Soil Science
University of Maine
Orono, Maine 04473

ICOMMORT =
International Committee
on Moisture Regimes In
Tropical Areas

Chairmanr Dr. A. Van Wambeke Department of Agronomy Bradfield& Emerson Halls Cornell University' Ithaca, NY 14053



Services d'Assistance Technique en Utilisation des Sols

Servicio de Apovo para el Manejo de Suelos

Soil Management Support Services P.O. **Box** 2890

Washington, D.C. 20013, USA Telephone: (202) 475-5330

Name of Project:

SOIL MANAGEMENT SUPPORT SERVICES (SMSS)

Implementing Agencies: 2.

> Soil Conservation Service. USDA Office of International Cooperation and Development, (OICD), USDA

- 3. Project Staff:
  - Principal Investigator Dr. Richard Arnold Director, Soils Survey Division Soil Conservation Service, USDA P. 0. Box 2890. Washington, D.C. 20013 Tel. (202) 382-1819
  - Project Leader Dr. Hari Esvaran Soil Management Support Services P. 0. Box 2890. Washington. D.C. 20013 Tel. (202) 475-5330 Telex. 8423 UHBSP HR
  - Project Monitor Dr. Ray Meyer Agency for International Development (S&T/AGR/RNR) State Department Washington. D.C. 20523 Tel. (703) 325-8993
  - Full time staff members - Dr. Hari Esvaran. Washington. D.C. - Secretary (Position vacant)

    - Dr. John Kimble, Lincoln, NE
  - Part time staff members
    - Mr. Terry Cook, (50%), SCS
    - Mr. William Reybold (10%), SCS

## 4. Information on the Project:

- a. Date commenced: October 1, 1979
- b. Date of extension: October 1. 1982
- c. Date ends: September 30, 1987
- d. Funding (FY1985):\$1,250,000.00

## 5. Project objectives:

- a. to provide technical assistance to AID and LDCs in problem identification, evaluation of opportunities and planning and utilization of land resources. especially in the subject areas of soil survey. soil conservation and soil fertility and management;
- to develop worldwide linkages for the more efficient utilization of agricultural information for crop production;
- c. to refine Soil Taxonomy for the Intertropical areas and assist LDC scientists in its "se and application in transferring agrotechnology from one region to another similar region.

## 6. Project activities:

In fulfillment of the first objective, TDYs were provided for:

- helping countries establish policies and programs for solving problems in land use and food and fiber production;
- 2. helping plan, carry out, and evaluate soil surveys and soil conservation programs;
- 3. providing laboratory and field testing services;
- 4. publishing soil management information that is needed in land-use planning and for food and fiber production;
- 5. conducting seminars and other training sessions on soil management improvements and soil classification;
- 6. interpreting soil properties to determine the potentials of the soils for agriculture and to predict their response to management; and
- 7. dissemination new ideas for increasing soil fertility. improving plant nutrition, and controlling soil erosion and sedimentation.

With respect to the second objective. developing linkages, SMSS has established and worked with more than 30 international organizations and with countless national institutions. Many of the International and regional organizations have supported SMSS sponsored workshops and training courses. Through SMSS initiative and in

collaboration with IBSNAT. an **ASEAN** network and an Oceanic network are being discussed. As a result of the assistance provided by **SMSS**, many countries are adopting the standards of SCS in their soil survey programs.

Because of the difficulties inherent in the program, SMSS has achieved least towards this objective. Through discussions and lectures, SMSS is encouraging national soil survey organizations to improve the interpretation potential of their soil surveys. SMSS hopes to embark on a soil-crop yield data base.

Probably much of the achievements has centered on the fourth objective. Today more than 40 countries use Soil Taxonomy as the primary system of soil classification and an equal number use it in addition to other systems. SMSS has 8 international committees working to refine Soil Taxonomy.

It has organized five soil classification workshops and thirteen training courses, and produces a number of publications and quarterly newsletter, which recently is published in collaboration with IBSNAT.

## 7. Collaborating institutions:

In the past six years, SMSS has had the privilege to work with the following organizations:

- 1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India
- 2. International Rice Research Institute (IRRI), Philippines
- 3. International Institute of Tropical Agriculture (IITA), Nigeria
- 4. Food and Agriculture Organization (FAO), Rome
- 5. United National Environment Program (UNEP), Kenya
- 6. International Soil Science Society (ISSS), Nederlands
- 7. Internation Soil Research and Information Center (ISRIC), Nederlands
- 8. Office de Recherche Scientific et Technique Outre-Mer (ORSTOM), France
- 9. Belgian Assistance Development Cooperation (ABOS/AGCD), Belgium
- 10. German Technical Assistance (GTZ), West Germany
- 11. Norwegian Technical Assistance (NORAD), Norway
- 12. Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Syria
- 13. World Bank, USA

- 14. Centro Agronomico Tropical de Investigation y Ensenanza (CATIE), Costa Rica
- 15. South East Asian Centre for Research in Agriculture (SEARCA), Philippines
- 16. Land Resources Division, Ministry of Overseas Development, Great Britain
- 17. International Benchmark Sites Network for Agrotechnology Transfer, (IBSNAT), Hawaii
- 18. Australian Centre for International Agriculture Research (ACIAR), Australia
- 19. International Board for Soil Research and Management (IBSRAM), Thailand
- 20. Kagera Basin Authority (KBO), Rwanda
- 21. Food and Fertilizer Technology Centre (FFTC), Taiwan
- 22. Centro Internacional de la Papa (CIP), Peru
- 23. Centro Internacional de Agricultura Tropical (CIAT), Colombia
- 24. International Fertilizer Development Center (IFDC), Alabama
- 25. Asian Development Bank (ADB), Philippines
- \*\* U. S. Universities and LDC national institutions are not included in this list.

## 9. Training Forums:

- a. Forum No.
- b. Country
- c. Date
- d. No. of Participants
- e. No. of Countries
- f. Collaborating institutions
- a. I
- b. Fiji
- c. 1980
- d. 25
- e. 8
- f. University of S. Pacific, Fiji
  Department of Agriculture, Fiji
  South Pacific Council, New Caledonia
  ORSTOM. France
  USAID/Suva
- a. II
- b. Morocco
- c. 1981
- d. 45
- e. 6

f. Institut National Recherche Agronomique.

#### Morocco

## Universiti Hassan II, Morocco

University of Ghent, Belgium

FAO, Rome

ACSAD, Syria

BSP, University of Hawaii/Puerto Rico

#### USAID/Rabat

- a. III
- b. Cameroon
- c. 1982
- d. 30
- e. 4
- f. Institut National Recherche Agronomique, Cameroon

BSP, University of Hawaii/Puerto Rico

FAO, Cameroon

ORSTOM, France

## USAID/Yaounde

- a. IV
- b. Thailand
- **c.** 1983
- d. 65
- e. 4
- f. Department of Land Development, Thailand IBSNAT, University of Hawaii/Puerto Rico FAO, Rome Rubber Research Institute, Malaysia

- a. VII
- b. Philippines
- **c.** 1984
- d. 35
- e. 3
- f. PCARRD. Philippines
  Bureau of Soils, Philippines
  IRRI, Philippines
  USAID/Manila
- a. VIII
- b. Jordan
- **c.** 1984
- d. 25
- e.
- f. Department of Agriculture, Jordan ACSAD, Syria University of Jordan USAID/Amman
- Near East Bureau, AID/W
- a. IX
- b. Guam
- c. 1984
- d. 30
- a. '
- f. University of Guam University of South Pacific. Fiji ACIAR, Australia Commonwealth Foundation. Great Britain DIS. West Germany USAID/Suva
- a. X
- b. Rwanda/Burundi
- c. 1985
- d. 45
- e. 3
- f. Carte Pedologic Rwanda
  Ministry of Agriculture, Rwanda
  Ministry of Agriculture, Burundi
  University of Burundi
  BADC, Belgium
  USAID/Kigali

USAID/Bujumbura

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ΙX
a,
     Zambia
b.
     1985
c.
d.
     65
e.
     Department of Agriculture, Zambia
f.
     University of Zambia
     NORAD, Norway
     BADC, Belgium
     CIDA, Canada
     IBSNAT
     USAID/Lusaka
     XII
a.
     Pakistan
b.
     1985
C.
d.
     35
e.
f.
     Soil Survey Of Pakistan
     Pakistan Agricultural Research Council
     FAO, Rome
     National Fertilizer Development Corporation
     Fauji Fertilizer Company
     Millat Tractors
     IBSNAT
     USAID/Islamabad
     XIII
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- a.
- Tunisia b.
- 1985 C.
- d.
- 11 e.
- f. Department of Agriculture, Tunisia ACSAD, Tunisia University of Ghent, Belgium University of Leuven, Belgium ORSTOM, France

**IBSNAT** 

## USAID/Tunisia

Near East Bureau. AID/W

- XIV a.
- b. Philippines
- 1986 C.
- d. 50 (planned)
- e.
- f. Ministry of Agriculture and Food, Philippines

- a. XV
- b. Western Samoa
- c. 1986
- d. 40 (planned)
- e. 15 (planned)
- f. University of South Pacific, Western Samoa
  University of South Pacific, Fiji
  Soil Bureau. New Zealand
  ACIAR. Australia
  South Pacific Agriculture Research and Development,
  Western Samoa

## USAID/Suva

## 10. Workshops, Seminars, Meetings:

4th. International Soil Classification Workshop

Rwanda. 2 - 12. June 1981

Theme: Classification-and management of Low

Activity clay soils and Andisols

Institute dea Sciences Agronomique, Sponsors:

Rwanda

BACD. Belgium

University of Puerto Rico University of Ghent, Belgium

USAID/Kigali

Participants: 41 Countries: 22

Proceedings: Published 1985

5th. International Soil Classification Workshop b.

Sudan, 2 to 11 November, 1982

Theme: Classification and Management of

Vertisols

Soil Survey Administration, Sudan Ministry of Agriculture, Sudan Sponsors:

ACSAD, Syria

University of Puerto Rico

USAID/Khartoum

Participants: 40 22 Countries:

Proceedings: Published 1985

6th. International Soil Classification Workshop c.

Chile, and Ecudar, 9 to 20 January 1984 Theme: Classification and management of

Andisola

University of Puerto Rico Sponsors:

USAID/Quito

American Embassy/Santiago

Sociedad Chilena de la Cienca del

Sue10

Universidad Austral de Chile Universidad de Concepcion

Pontifica Universidad Catolica de

Chile

Universidad De Santiago

Sociedad Ecuatoriana de la Ciencia

del Sue10

Ministerio de Agriculture y

Ganaderia, Ecuador

Participants: 39 Countries: 17

Proceedings: In Press d. 7th. International Soil Classification Workshop

Philippines, 26 March to 5 April 1984

Theme: Characterization. Classification and

utilization of Wetlands Soils

sponsors: IRRI, Philippines

Bureau of Soils, Philippines

USAID/Manila

Participants: 83 Countries: 23

Proceedings: Published 1985

e. 8th. International Soil Classification Workshop

Brazil, May 9 to 26, 1986 Theme: ICOMLAC/ICOMOX

Sponsors: EMBRADA

University of Puerto Rico

Participants: 100 Countries: 14 Proceedings: 1987

## 11. Monographs and publications

## Technical Monographs

- a. Authors et. al.
- b. 1981
- c. Soil Resource Inventories and Development Planning-Tech. Monograph No. 1
- d. USAID, SMSS, USDA/SCS, Cornell University
- e. Out of print
- a. A. Van Wambeke
- b. 1982
- c. Soil **Moisture** and Temperature Regimes South America-Tech. Monograph No. 2
- d. Cornell University, SHSS
- e. 200
- a. A. Van Wambeke
- b. 1982
- c. Soil Moisture and Temperature Regimes Africa-Tech. Monograph No. 3
- d. Cornell University. SMSS
- e. 100
- a. Terry Forbes, D. Rossiter, A. Van Wambeke
- b. 1982
- c. Guidelines for Evaluating the Adequacy of Soil Resource Inventories-Tech Monograph No. 4
- d. Cornell University, SMSS
- e. Out of print

- a. Walter Luzio L., et. al.
- b. 1982
- c. Taxonomia De Suelos (Abridged Spanish translation)
  -Tech. Monograph No. 5
- d. Universidad de Chile, Cornell University, Nacional de Tecnologia Agropecuaria, Argentina
- e. 200
- a. USDA/SCS Soil Survey Staff
- b. 1983
- c. Keys to Soil Taxonomy-Tech. Honograph No. 6
- d. USDA/SCS, SMSS, Cornell University
- e. Out of print
- a. USDA/SCS Soil Survey Staff
- b. 1985 (revised)
- c. Keys to Soil Taxonomy-Tech. Monograph No. 6
- d. USDA/SCS, SMSS, Cornell University
- e. 1500
- a. James H. Brown
- b. 1984
- c. Universal Soil Data Base and Map Display System-Tech. Honograph No. 7
- d. Pedologues Incorporated, SHSS
- e. 250
- a. Frank R. Moormann
- b. 1985
- c. Excerpts from the Circular Letters of ICOMLAC-Tech.
  Monograph No. 8
- d. ICOMLAC, University of Hawaii, SMSS
- a. 300
- a. A. Van Wsmbeke
- b. 1985
- c. Soil Moisture and Temperature Regimes Asia-Tech. Monograph No. 9
- d. Cornell University. SNSS
- e. 1.700

#### Benchmark Soils Of The World

- a. T. R. Forbes, et.al.
- b. 1985
- c. Benchmark Soils of the Yemen Arab Republic -Benchmark Soils of Monograph No. 1
- d. Cornell University, SMSS
- e. 1,000

- a. L. Moncharoen, et.al
- b. 1986
- c. Benchmark Soils of Thailand Benchmark Soils Monograph No. 2
- d. Department of Lend Development Thailand
- e. 1.000

#### Newsletters

- a. Staff
- b. October 1981
- c. Soil Taxonomy News #1
- d.
- e. 50
- a. Staff
- b. January 1982
- c. Soil Taxonomy News#2
- d.
- e. 50
- a. Staff
- b. June 1982
- c. Soil Taxonomy News #3
- d.
- e. 50
- a. Staff
- b. September 1982
- c. Soil Taxonomy News #4
- d.
- e. 50
- a. Staff
- b. February 1983
- c. Soil Taxonomy News #5
- d.
- e. 50
- a . Staff
- b. **August** 1983
- c. Soil Taxonomy News #6
- d
- e. 50
- a . Staff
- b. January 1984
- c. Soil Taxonomy News #7
- d.
- e. 50

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a. Staff
     b. August 1984
     c. Soil Taxonomy News #8
         50
     e.
     a. Staff
     b. November 1984
     c. Soil Taxonomy News #9
     d.
         50
     e.
     a. Staff
     b. April 1985
     c. Soil Taxonomy News #10
     d.
         50
     e.
     a. Staff
     b. September 1985
     c. Agrotechnology News No. 1
     d.
         50
     e.
     a. Staff
        February 1986
     c. Agrotechnology New No. 2
     d.
         50
     e.
Brochures
         Staff
     a.
         1980
     b.
         Soil Management Support Services -
     С.
           A project for international assistance
     d.
     e.
         Out of print
         Staff
     a.
         January 1984
     b.
         Soil Management Support Services -
           A project for international assistance
     d.
         300
     e.
         Staff
    a.
        January 1986
        SMSS or Designation for Master Horizons and Layers in soil
    d.
         Cornell University, SMSS
```

200

e.

- a. Staff
- b. October 1985
- c. Soil Management Support Services Training Brochure
- d.
- e. 300

#### **Progress Reports**

- a. Staff
- b. October 1, 1979 September 30, 1984
- c. Progress Report SMSS
- d. Pedologues Incorporated, SMSS
- e. out of print
- a. Staff
- b. October 1, 1982 1983
- c. Progress Report SMSS
- d. University of Hawaii SMSS
- e. 200

#### Bibliographies

- a. Arnold C. Orvedal
- b. June 1983
- c. Bibliography of the Soils of the Tropics Vol. V. Tropics in General and Tropical
- d. USDA/SCS, OCID, SMSS, National Agricultural Library
- e. 100

#### International Training Forum Proceedings

- a. R. Morrison, D. M. Leslie. Editors
- b. November 1981
- Forum on Soil Taxonomy No. I
- d. University of S. Pacific Fiji, SMSS
- e. 5
- a. S. Panichappong, L. Moncharoen, P. Vijarnson Editors
- b. February 1983
- Proceedings of the Fourth Tnternational Forum on Soil Taxonomy and Agrotechnology Transfer -- No. IV
- d. The Department of Land Development Thailand, SMSS
- e. 200
- a. Carlos F. Burgos, et.al. Editors
- b. 1984
- Memoria del Sexto Foro Taxonomia De Suelos No. VI
- d. CATIE, SMSS
- e. 100

- a. A.R. Maglinao, T. M. Metra, M. R. Recel, P. J. Lastimosa, Editors
- b. 1985
- c. Soil Taxonomy: Tool for Agrotechnology Transfer
  Proceedings of the VIIth International Forum
  on Soil Taxonomy and Agrotechnology Transfer No. VII
- d. CARRD, SHSS
- e. 200
- a. A. Oman, et.al.
- **b.** 1985
- Proceedings of the VIIIth International Training Forum on Soil Taxonomy and Agrotechnology Transfer - No. VIII
- d. ACSAD, SMSS
- e. **250**
- a. J. Demetrio. et.al.
- **b.** 1985
- c. Proceedings of the IXth International Training Forum on Soil Taxonomy and Agrotechnology Transfer No. IX
- d. University of Guam, SMSS
- e. 400

#### International Soil Classification Workshops

- a. M. N. Camargo, F. H. Beinroth. Editors
- b. 1978
- c. Proceedings of First International Soil Classification Workshop
- d. EMBRAPA, SMSS, University of Puerto Rico
- e. Out of Print
- a. F. H. Beinroth. S. Paramananthan, Editors
- b. 1979
- c. Second International Soil Classification
  Workshop Part I Malaysia, Part II Thailand
- d. National Soil Survey, Malaysia. Soil Survey
  Division, Thailand, University of Puerto Rico, SMSS
- e. Out of print
- a. F. H. Beinroth, A. Osman, Editors
- **b.** 1981
- c. Proceedings Third International Soil Classification
  Workshop
- d. ACSAD. Soil Science Institute of Greece. Geologosich Institut, Gent, Belgium, University of Puerto Rico. SMSS
- e. Out of print

- a. F. H. Beinroth, et.al. Editors
- b. 1985
- c. Proceedings of the Fourth International Soil Classification Workshop
- **d.** Ministry of Agriculture, Rwanda, University of Puerto Rico, SMSS
- e Not Available
- g. F. H. Beinroth. M. Ali, H. Osman, et.al. Editors
- b. 1985
- c. Proceedings of the Vth International Soil Classification Workshop
- d. Soil Survey Administration. Sudan. University of Puerto Rico. SMSS
- e. Not Available
- a. F. H. Beinroth, W. Luzio, L. F. Maldonado, et.al. Editors
- b. 1986
- c. Proceedings of the **VIth** International Soil Classification Workshop
- d. Ministry of Agriculture, Chile and Ecuador, University of Chile, Soil Science Society of Chile and Ecuador, University of Puerto Rico, SHSS
- e. In press
- a.
- b. 1985
- c. Proceedings of the **VIIth** International Soil Classification Workshop
- d. IRRI, Bureau of Soils. SMSS
- e. 200

#### Audio Visual Aids

- a. Staff
- b. **August** 1982
- c. Soil Taxonomy: A Technical Language of Soil Science
   (a slide and cassette tape, a 16mm film, a 8mm
   film)
- d. Cornell University, SHSS
- e. Limited quantities
- a. Staff
- b. May 1986
- c. Training Forums video tape
- d. Cornell Univeristy, SMSS
- e. In draft copy

#### **Computer Software Programs**

- a. S. W. Buol, R. A. Rebertus
- b. 1985
- c. Soil Taxonomy Keys to Classification Computer '
  Software Programs No. 1 Interactive Program to
  Classify Soils Using Soil Taxonomy
- d. North Carolina State University. SNSS
- e. 250

#### 12. Linkages (Fig. 1)

a. **USAID** Projects

SHSS collaborates with IBSNAT and TSMK. With IBSNAT, it has a joint newsletter (Agrotechnology Transfer); SMSS also characterizes some of IBSNAT experimental sites and IBSNAT provides management information for SHSS World Benchmark Soils Database. SMSS and IBSNAT cost-share some of the training activities and some meetings.

SMSS and TSMM has cost-shared a workshop and some

- b. <u>International Agricultural Research Center</u> SMSS has good working relations with ICRISAT. IITA and IRRI. Have organized joined vorkshops.
- c. USAID Country Missions

Missions have always supported SMSS activities. A few like USAID/Bangkok, USAID/Suva, USAID/Lusaka, USAID/Amman and USAID/Islamabad have even funded SMSS activities. Near East Bureau of AID/W provides annually \$50.000 to organize training courses.

#### 13. (a) Major Achievements

- Excellent rapport with LDC institutions and USAID Missions.
- Many countries (fig. 2) use Soil Taxonomy and soil survey procedures of SCS-USDA.
- Publications are used and referred to in technical discourses and some sre translated.

Training courses largely funded by others; well attended and good feed-back.

- Workshops, cost-shared and participated by world-reowned soil scientists.
- SMSS honoured by several organizations including the Governor of Guam.

#### (b) Major constraints

- SCS-USDA staff-ceiling prevent hiring of new staff.
- Project has poor secretarial support and for the moment, "one.
- OCID's contractual procedures cumbersome and in some instances restricts utilization of talented or experienced persons.
- USAID Bureaus and many USAID Country Missions are not well informed of S&T's centrally funded projects.

#### 14. Utilization and impact

Because SHSS is a world-wide program, it cannot have the kind of impact as a country-specific project. Nevertheless, there is some evidence of the project outputs being utilized.

This does not include the salaries and other services of the many persons who contributed to the activities.

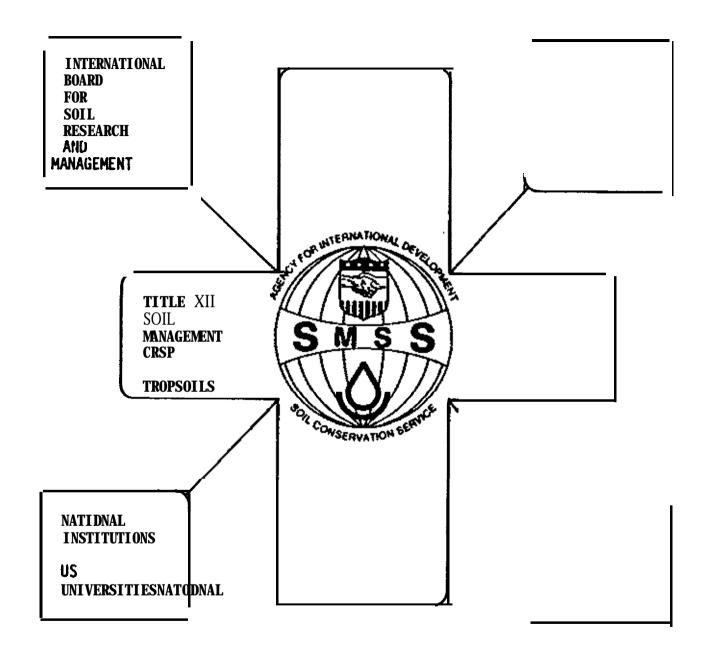
The training workshop components are also bearing fruit, with countries developing their own in-service training programs usino SMSS training packages. ACSAD is a" example of a regional institution which as obtained \$175.000 from the Arab League, to conduct its own training In Arabic on Soil Taxonomy. SMSS Monograph No. 6 -- Keys to Soil Taxonomy -- is now translated into Spanish, French. Japanese, Chinese, Italian. Malay, Thai and the Greek translation is being worked on.

**SMSS** continues to service **USAID** Bureaus and Missions and the technical assistance component is maintaining its momentum.

In conclusion, there is ample evidence to Indicate that SMSS activities are useful, necessary, appreciated and followed up.

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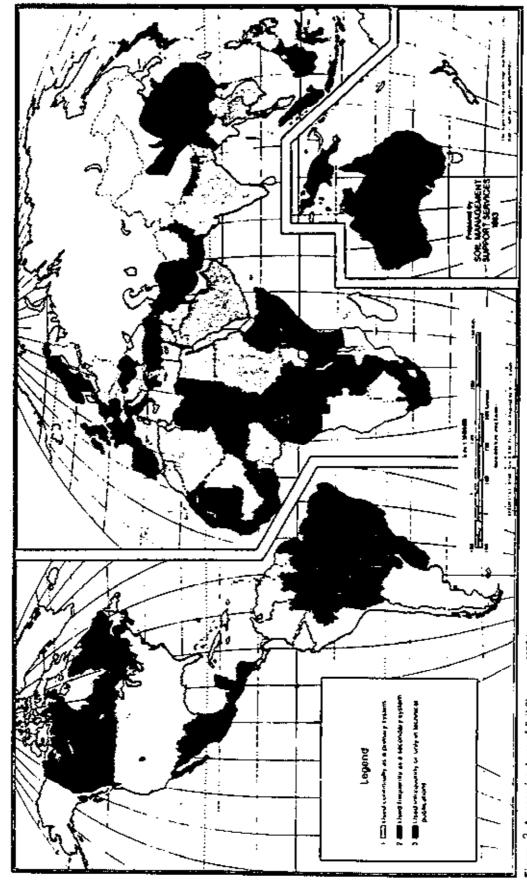


Figure 2. International use of Suif Busaomy (1984).

J.E. Witty

## SOIL CLASSIFICATION COMMITTEES

The purpose of this report is to review the activities of the International Soil Classification Committees and to encourage active participation in these committees. I am also leaving plenty of time for questions to make sure that I cover as much as possible the topics in which you are most interested.

The committees were organized to help coordinate the improvement of Soil Taxonomy and to make it a comprehensive system. The committees have an open membership and the chairmen of the respective committees correspond with the membership by "Circular Letters".

I believe it is fair to say that most of the committees have concentrated on trying to make Soil Taxonomy more usefulin areas where little soils data was available at the time it was published. Soil Taxonomy is considered a de facto international soil classification system, and I thin):: this is due to the work of the committees.

I believe we all benefit from maintaining Soil Taxonomy as a comprehensive system. If we had looked only inward, in other words, if we had only considered the soils of the U.S.

when developing and maintaining Soi 1 Taxonomy, the committees would not have been needed. I like Guy Smith's thoughts on why we should look "outward" for help with Soil Taxonomy. Hewrites: "A comprehensive system should let us see the soils of the United States in better perspective."

The International Committee on Low Activity Clay completed its mandate about two years ago. Since that time the proposal was sent out by the Soil Conservation Service for testing. Last winter the comments were evaluated and incorporated into the final amendment. Through the spring it has gone through additional testing, with a few changes made. The amendment is essentially ready to be released, but Frank Moormann made a special request to look at it one more time before we release it. We are waiting for his final comments.

The major changes resulting from this amendment are:

- 1. The introduction of a new diagnostic horizon, the kandic horizon, which is identified on the basis of (a) having a clay increase similar to that defined for an argillic horizon, and (b) having a CEC of ≤16 meq/100 g of clay (In some cases the kandic horizon will also be recognized as an argillic horizon), and
- 2. The introduction of "kandi" and "kanhapl" great groups of Alfisols and Ultisols. These great groups parallel the "pale" and "hapl" great groups, respectively, concerning clay distribution with depth.

In the United States the approval of this amendment will have the greatest impact on classification of the soils in the

the true benefits of reclassifying our soils on the basis of this amendment, but surely it will facilitate the transfer of information about the management of these soils from other parts of the world. It will also emphasize the main limitations of these soils.

The International Committee cm Oxisols is putting the final touches on the ICOMOX proposal before submitting it to the Soil Conservation Service to send out for final testing.

The ICOMOX committee has been active fur about 8 years, and 16 Circular Letters have been published.

The VIII International Soil Classification Workshop was held in Brazil on Oxisols in May, 1986. Approximately 70 full-time participants attended the workshop, which included both paper sessions and examination of Oxisols in the field. The field tour was conducted between SaoPaulo and Brasilia, where 22 pedons with complete characterization data were examined and classified. The purpose of the workshop was to help solve the remaining problems with the Oxisol proposal. I thought the workshop was very successful, and good agreement was reached concerning the final format of the proposal.

Acceptance of the ICOMOX proposal will have Iittle impact on the classification of the soils of the United States, because the SCS only recognizes about 39 soil series classified as Oxisols. These are in Puerto Rica, Hawaii,

the Trust Territory, and Guam. It appears, however, that all 33 series will require reclassification.

The International Committee on Andisols was established in 1378 after Guy Smith prepared a report recommending that a new order, Andisols, be established. Progress has been steady with this committee, and hopefully it will submit its final proposal to SCS by late 1987.

Two events have been scheduled to aid in finalizing derisions. The first is an International Soil Correlation Meeting which will be held July 20 to 31, 1986 and will be the first such meeting held of this type. At this meeting we will concentrate on examining a wide range of "Andisols" in Idaho, Washington, and Oregon. Participation in the International Correlation Meeting is restricted to about 40 people mostly for logistical reasons — one being that only one bus will be required. The correlation meeting will not be as "international "as the workshops, in that only 4 other countries will be represented besides the U.S. Most of the participants will be from the West or Northwest.

The second event is the 9thInternational Soi 1
Classification Workshop scheduled for July, 1987 in Japan.
At this workshop decisions should be made on al 1 remaining problems with the ICMAND proposal, and the final proposal is expected to be received by the SCS in the fall of 1987.

The International Committee on Moisture Regimes has been "on hold" for the last 3 or 4 years. In 1982 the committee had decided that they had done about as much as they could do based on the current research on soil moisture at that time. SCS has not followed up on the committee's proposals. The proposals consisted basically of subdividing the existing soil moisture regimes into three subclasses each. We are trying to revive the committee to either develop a new model or improve the Newhall Model. It is generally felt that we could test the ICOMMORT proposal, but we need a better mechanism for applying the 1 i mits when making soil surveys.

Ron Paetzold is working on soil moisture and temperature regimes and is making an inventory of the ongoing and completed studies conducted in the U.S. He will also help evaluate existing models to deter-mine if it is practical to use or modify them for use to estimate soil moisture and temperature regimes. Two possible models are the SPAW model developed by Keith Saxon of Pullman, Washington, and the CREAMSTAX model, which is a modification of the CREAMS model.

The International Committee cm Aridisols has progressed slowly. The third International Soil Classification

Workshop was held in Syria and Lebanon in 1980 to address the taxonomy of soils in arid zones of low latitudes. The workshop was quite a success as far as identifying problems in the management and classification of these soils, but

there was a lack of significant follow-up by ICOMID.

Recently there has been an increase in activity, and currently there are plans to hold an International Soil

Correlation Meeting on Aridisols in 1987 in the Southwestern part of the U.S.

In the past the committee concentrated on Aridisols with accumulations of carbonate and gypsum and tried to define a couple of new diagnostic horizons, the hypergypsic and hypercalcic horizons. Now there is a more general feeling that the whole order should be examined. At present there are only two suborders recognized, but if the Orthids, for example, were split into Calcids, Gypsids, Salids, etc., more meaningful groupings could be made at the great group and subgroup levels.

The International Committee on Vcrt isols is completing its mandate, and the chairman is preparing the final ICOMERT recommendations to be submitted to the SCS. After receiving the recommendations we will send them out for worldwide testing.

Some of the major changes being recommended by ICOMERT are:

Deletion of gilgai as a criterion fur recognizing Vertisols;

introducing an aquic suborder; discontinuing the use of

pellic and chromic great groups based on color and

introducing dystric, eutric, duric, and salic great groups.

The International Committee on Wet Soils had a slow start under the chairmanship of Frank Moormann. He gathered a lot of introductory information but never had the time to prepare a circular letter. In 1984 he submitted his resignation as chairman and recommended that Johan Bouma be designated as the new chairman. We followed up on his recommendation.

Since Johan became chairman, he has distributed 4 Circular Letters and generated a lot of responses. Some of the major questions are: (a) Should the aquic moisture regime be defined on the basis of saturation only or should it require saturation and reduction? (b) Should the pseudogleys be distinguished from the groundwater gleys at a high level? (c) Should drained soils be distinguished on the basis of taxon criteria or phase criteria? (d) Should soils that are saturated for periods of time but do not become reduced be recognized at the subgroup level? (e) Should morphometric criteria be used to define aquic suborders, or should they be identified on the basis of measured periods during which they exhibit reducing conditions or on the basis, of depth and season of water-table? Dr. Bouma is planning to complete his mandate by 1988.

The International Committee on Spodosols has had a difficult time. Ted Mi 1 ler was selected as chairman when the committee was first established. He resigned, however, when he retired from the SCS, and Bob

established, and the data base is being manipulated to test different hypotheses. A major problem, however, is that the data base, for the most part, is based on our standard soil analyses, and it has been manipulated to death over the last 20 years. We need new analyses to test the Spodosols, and certain Universities and Countries are trying new analyses but they are very expensive to screen. Some of the new tests may give good separation among the local soils tested, but the tests disintegrate when a wide spectrum of sails are used. The only thing on which we can get good agreement is that if it looks like a Spodosol we should classify it as a Spodosol.

This completes my discussion of the established ICOM's. Recently, however, we have received recommendations to establish two more ICOM's, one on soil families and the other on Histosols. The one on soil families would be a follow-up to Ben Hyjak's work on soil families. The other would be to fill in gaps in the Histosols at lower latitudes.

At one time it was thought that additional committees should not be established until most of the established ones had completed their mandates. Overall, I think the committees have been quite successful. It is not a very efficient approach to improving Soil Taxonomy, but I do not know a better one.

#### Business Meeting

#### 1. 1988 Conference Host

Hawaii was selected as the next conference host state. Harry **Sato** and H. Ikaws **will** co-chair.

Steering committee to review possibilities and select conference field trip theme. Also, date will be determined. A summer date is probable.

Some possible field trip options include:

- a. Soil moisture (climate) project on Maui.
- b. IBSNAT (Agro-technology transfer).
- c. View and discuss andic soils.

Some combination of the above also is possible.

A second alternative — in case Hawaii is not approved — is Washington and Idaho as co-hosts. A possible field trip is to look at a transect of soils on similar parent material with a change in precipitation.

#### 2. Taxonomy Committee

Wayne Robbie, USDA Forest Service, Southwest Region and Gordon Huntington, university of California, Davis were approved for 3-year terms on the West Regional Soil Taxonomy Committee.

#### 3. Committee Format

Dick Kover discussed the change in committees recommended by the Steering Committee for this conference. That is, conference format include:

- ${\bf a.}$  Conference Committees These are to jointly address a few of the key issues needing development of techniques, procedures or policies.
- b. Standing Committees These are ongoing committees with specified membership and terms of membership. Currently. these are Soil Taxonomy, Soil Interpretations, Research Priorities, and Laboratory Techniques.
- c. Task Force Small groups of specified individuals to address a single issue or function with termination at the conference.

#### Discussion:

There was general consensus for this format as presented.

A request was made for a list of membership on standing comittees.

Should consider outside speakers if the topic is appropriate to NCSS objectives.

#### MEMBERSHIP LIST

of the

#### WESTERN REGIONAL TECHNICAL WORR PLANNING CONFERENCE FOR SOIL SURVEY

I. state Soil Scientists. Soil Conservation service:

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# WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE 51 N.W. Rroadway, Room 547

Portland, Oregon 97209-3489

Telephone (503) 221-2851

FIELD TOUR

June 25, 1986

**Summary Information Prepared** 

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Robert T. Heurisse Leader, Soils Group Pacific Novibuest Region USDA Forest Service

#### Tour Guides:

George Green, Assistant State SoilScientist, USDA-SCS, Portland Jerry Simonson, Professor, Soils, Oregon Ag., Exp. Stn., OSU, Corvallis Jerry Latshaw, State Soil Scientists, USDA-SCS, Portland Bob Meurisse, Leader Soils Group, USDA-Forest Service, Portland

#### West Region

#### National Cooperative Soil Survey

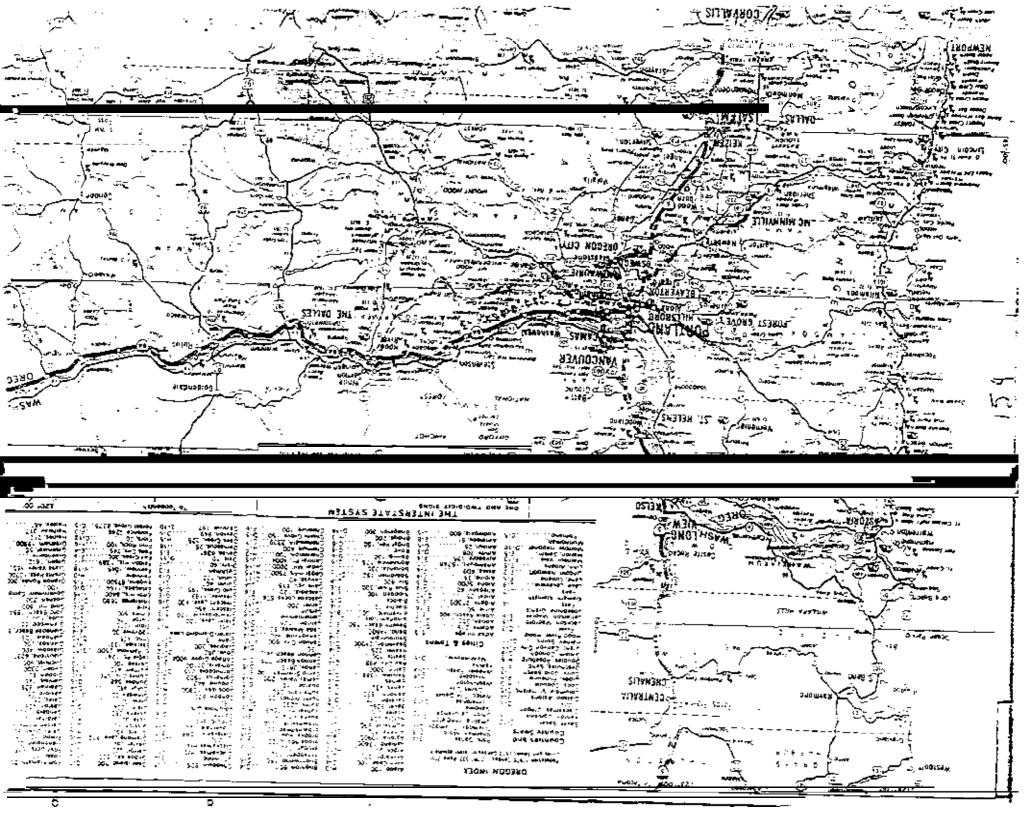
Field Trip

June 25. 1986

#### <u>Agenda</u>

Soils, landforms, vegetation relationships, and land use from the Willamette Valley to the Cascades, near Mt. Wood, descending to the llood River Valley. Discussions will emphasize morphology, genesis, properties, uses and management of the soils.

7:30 a.m.	Depart Portland Inn
8:15 a.m.	stop 1 - Powell Series (Typic Fragiochrepts)Greshamarea
	Jerry Latshaw - discussion leader
10:00 a.m.	Stop 2 - Bull Run Series (Umbric Vitrandepts) Mt. Hood National Forest
	Roh Meurisse-discussion lender Steve Mellor - briefly discuss management in the Bull Run municipal supply watershed, Mt. Hood National Forest
12:00 Noon	Bull Run Lake - Lunch Steve Mellor - discuss blowdown and salvage operations in Bull Run Watershed
1:15 p.m.	Stop 3 - Thader Series (Humic Cryorthods) Mt. llood Nnt ional Forest Jerry Simonson - discussion lender
2:45 p.m.	Stop 4 - Parkdale Series (Umbric Vitrandepts) Hood River Valley area George Green - discussion lender
4:30 p.m.	Leave for return to Portland via I-84 Columbia River Gorge
6:00 p.m.	Arrive Portland Inn



### GEOLOGY OF THE CASCADE RANGE IN OREGON AND SOUTHERN WASHINGTON 1/

The Cascade Range, part of a continuous mountain chain "ear the western margin of the North American continent, extends from Lassen Peak in northern California through Oregon and Washington. Through the central part in Oregon and in southern Washington, the Cascade Range is divided into two distinct provinces: the geologically young High Cascades and the older Western Cascades. Bothbelts are mostly of volcanic extrusive origin; both include subordinate amounts of near surface intrusive rocks, some continental sedimentary deposits, and surficial deposits related to stream or glacial erosion and to several kinds of mass wasting.

Physiographically, the range is characterized by a long western slope that descends irregularly to low valleys in the Willamette-Puget lowland or coalesces locally with the Coast Range or Klamath Mountains on the west. The fairly abrupt eastern slope descends to lavaplateaus east of the Cascades. The higher casternpart of the range consists of a narrow volcanic plateau at average elevations of about 5,000 to 6,000 feet. It is surmounted by a number of steep-sided volcanic cones including Mt. Rainter(14,408 feet), Mt. Adams, and Ht. St. Helens in Washington; and Mt. Hood (11,235 feet), Mt. Jefferson, Three Sisters, and Mt. McLoughlin

Availanches, rockfalls, and landslides from oversteepened slopes also have contributed to erosion all along the Cascade Range. Large mudflows, composed of uncorted masses of angular to subrounded fragments suspended in water, originated high on Cascade Peaks and poured down glactal and stream valleys.

#### Geomorphic Surfaces 2/

Local geomorphic surfaces were mapped on high-altitude acrial photographs. The surfaces are named for areas where they are particularly well expressed. The numbers, in order of increasing age, are Horseshoe, Ingram, Luckiamute, Winkle, Champoon, School, Bethel, Dolph, and Rola. The steep, mountainous topography is critical the Looney Unit but fits no particular span of time. The surfaces and some features are as follows:

Surface Norweshoe Ingram Minkle

Champoeg Senecal Bethel Dolph

Unia Early Pleistocene

erosional remnants 600+

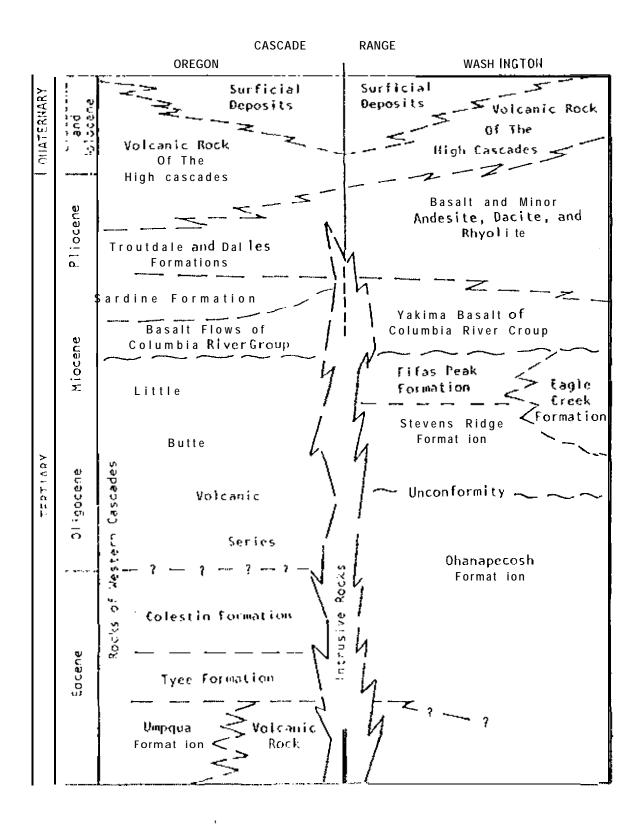


Figure 1. Rock formational units in the Cascade Range, Oregon and Washington, arranged to show their time sequence relations.

3

CLIMATE OF MULTNOMAH COUNTY AND THENT-HOOD NATIONAL FOREST AREA 1/

Air flow is primarily easterly from the Pacific Ocean. Normally, warm moist air moves eastward

Soil Moisture and Temperature Regimes

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# NATURAL VEGETATION OF THE NORTHERN WILLAMETTE VALLEY AND NORTHERN OREGON CASCADES 1/2/

# WI llamette Valley

Riparian Communities - Typical riparian forests in the northern Willamette Valley In the lower Willamette and Columbia Rivers are dominated by black cottonwood. Associated species includerigid willow, Scouler's willow, red willow and soft leaved willow. Oregon ash is characteristic on seasonally flooded and swampy hatitat. Big leaf maple also is common as is red alder.

Valley Floor and Foothills - Before settlement, much of the Willamtte Valley was occupied by prairie and oak savannas. These were created and maintained by fires probably used by native Americans. Douglas-fir is the dominant evergreen tree in the remnant forest areas. Oregon white oak, big leaf maple and pacific madrone are common broadleaf species. Common understory species include poison oak, dogwood, ocean spray and western hazel. Swordfern, oxalis and white hawk weed are common in the forest floor.

#### Cascades

Four conifer series span the forested portion of the Oregon Cascades. The western hemlock series dominates relatively warm moist sites below about 3,000 feet elevation west of the Cascade Crest. Canopy species include Douglas-fir, western hemlock, western red cedar and, on recently disturbed sites, red alder. Understory species reflect relative moisture and temperature conditions. Devil'sclub, salmonberry, oxalisandswordfern indicate abundant moisture through the growing season and, generally, high site productivity. Oregongrape and vanilla leaf dominate more well-drained sites. Rhododendron is most abundant on poorer sites with thin, rocky soils.

The Pacific silver fir series occurs in a band between about 3,000 feet and 5,000 feet elevation west of the Cascade Crest and slips east of the Crest down to about 4,500 feet. At lower elevations, the Pacific silver fir and western homlock series overlap. This series indicates cooler climatic conditions, usually with substantial winter snowpacks. Pacific silver fir, Douglas-fir,

<sup>1/</sup> From: Franklin, J. and C.P. Dyrness 1973, Natural Vegetation of Oregon and Washington, USDA, Gen. Tech. Report, PNW 8.

<sup>2/</sup>Information derived from R-6 Ecology Program - Miles Hemstrom, Area Ecologist, Willamette and Siuslaw National Forests and Nancy Halvorson, Area Ecologist, Mt. Hood and Gifford Pinchot National Forests.

western hemlock, noble fir, westernwhitepine, and mountain hemlock are the major canopy species. Important understory species include Oregongrape, vine maple, salal and, on poorer sites, rhododendron. At upper elevations, big buckleberry and beargrass become dominant species. Timber management is more difficult in the Pacific silver firzone. Deep snowpacks, short growing seasons, growing season frost and poor soils contribute to difficult regeneration and relatively slow tree growth rates.

At the upper limit of closed canopy forest (to about 6,000 feet) mountain hemlock is the major climax species. Big huckleberry, grouse huckleberry and heargrass characterize the understory. Snowpacks are deep, growing seasons short and soils generally poor in this zone. Opening fill in very slowly, usually with naturally seeded lodgepolepine and white pine or advanced tegeneration of noble fir, Pacific silver fir and mountain hemlock.

East of the Cascade Crest, below 4,500 fret, grand fir and, on drier sites, bouglas-fir are the major climax species in areas that support forests. canopy species include Ponderosa pine, western larch, Douglas-fir, and grand fit. Lodgepole pine occurs in extensive stands on deep volcanic ash soils.

Chinquapin, vine maple. service berry. rose. vanilla leaf and grasses dominate the understory in more moist areas. Bitterbrush and sagebrush are important on drier sites. Regeneration can be difficult, although ponderosa pine may do well. Growth rates are usually lower than west of the Cascade Crest.

Soils

The soils of Multnomah

Multnomah Series - Fine-loamy oversandy or sandy skeletal mixed mesic Dystric Xerochrepts. Very deep, well drained soils on terrace. They are on the Champoeg surface at elevations of 150 to 400 fret.

Principal use and Management-Berries, grains, vegetables, nursery stock and pasture. Irrigated for maximum production. Berries respond to N, P, K, S and sometimes R. Also used for urban development with no major limitations for homesites. Ground water may be contaminated from septic tank absorption fields.

Powell Series (Stop 1) - Fine-silty, mixed, mesic Typic Fragiochrepts. Deep, somewhat poorly drained soils on broad, high terraces. They are on the Rethel surface at elevations of 300 to 600 feet.

PrincipalUseand Management - When drained, major crops are grain, berries, vegetables, nursery stock, hay and pasture. Summer irrigation for maximum production and subsoiling to break up tillage pans. Grain and grass responds to N. Berries respond to N. P. K. Sandsometimes R.

Areas not cultivated are in Douglas-fir, western red ceder, red alder. big leaf maple and dogwood. These areas are mostly on the edge of the valley.

1 noreasingly, homesites are constructed on these soils. The seasonal water table often requires drainage. Septic tank absorption fields do not function properly during rainy periods.

<u>Cazadero Series</u> - Clayey, mixed, mesic Typic Rhodudults. Deep, well drained soi In on terraces from old alluvium. They are on the Eola surface at elevations of 600 to 1500 feet.

Principallise and Management ~When cultivated, they are used for hay and pasture, some berries, vegetables and nursery plants. They are also used for forestry. Douglas-fir is the most important species. Site index for Douglas-firis 155 to 172 (based on 100 yrs.) At a site index of 165, the soils are capable of producing 74,200 board feet/acre at 80 yrs. of age.

BullRun Series (Stop 2) - Medial, mesic Umbric Vitrandepts. Very deep, well drained soils formed in silty materials and volcanic ash. They are on the stable ridges and benches at elevations of 500 to 1500 feet.

Principal Use and Management - Used mostly for timber production, watershed management and wildlife habitat. Managed mostly for Douglas-fir, some western hemlock and western red cedar. Site

Unincipal Use and Management - Similar to Bull Run, but afte index for Douglasfor is 140 to 155. Zygore Series - Medial-skeletal, frigid Andic Haplumbrepts. Deep, well drained soils on mountainous slopes. Formed in colluvium and glacial till from basalt and andesite at elevations of 1500 to 3000 feet. Principal use and management-similar to Bull Run. Site index for Douglas-firis 160 to 170. Plant available water capacity is 4 to 6 inches. Water holding capacity is 21 to 26 inches.

Thadr Series (Stop 3) -Loamy-skeletal, mixed. Humic Cryorthods.

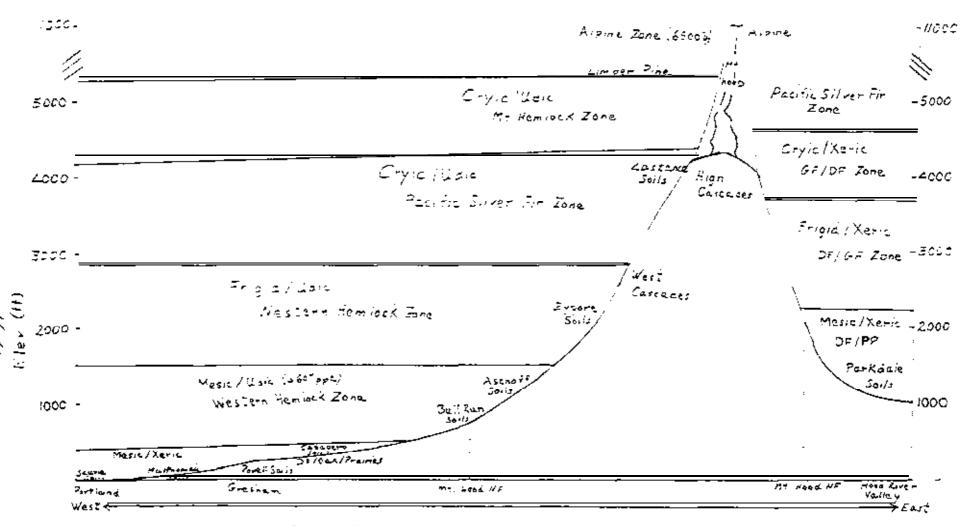
Deep, well drained soils on broad ridges in mountainous areas. Formed in colluvium and glacialtill from andesite and basalt mixed with volcanic ash.

Principal Use and Management - Used mostly for timber production, watershed management and wildlife habitat. Managed mostly for noble fir, Pacific silver fir and western hemlock. Site index for noble fir is 50 to 70. At site index of 52, 70 year old stands are capable of producing 14,300 bd. ft/ac. Cold soils 1 imit productivity end plant succession is slow when disturbed.

Parkdale Series - (Stop 2)-Medial, mesic, Umbric Vitrandspts. Deep, well drained soils Formed in deep mudflows high in pyroclastic materials. They are at elevations of 1000 to 2500 feet.

Principal Use and Management — Used mostly for apple and pear orchards. Some are used for timber production. Dominant species are Douglas-fir. Some grand fir and ponderosa pine also are grown. Site index for Douglas-fir averages about 130.

'The orchards are largely Delicious and Newton apples and Bartlett, Bosc and d'Angou pears. High level management yields 850 boxes/ac apples and 950 boxes/ac. pears. Orchard trees respond to N. Sometimes, magnesium, boron or zinc are applied as foliar sprays.



Sell moisture and temperature regimes, representative soils and regatation somes on an Cartiwest transact from Portland in the Willamete Valley across the Cascades to the Hood River Valley.

(Scale Imm 7 5.2 ml)

 $RTm_c$ 

LOCATION POWELL

Established Series Rev. RWL/AON 12/81

#### **POWELL SERIES**

The Powell series consists of deep, somewhat poorly drained soils that formed in silty materials over old silty alluvium Powell soils are on broad high terraces and have slopes of 0 to 30 percent. The mean annual precipitation is 55 Inches and the mean annual air temperature is about 52 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, mesic Typic Fragiochrepts.

TYPICAL PEDON: Powell silt loam, cultivated. (Colors are for moist soil unless otherwise noted.)

Ap--0 to 8 inches; dark brown (10YR 3/3) \$11t loam, brown (10YR 5/3) dry; moderate very fine granular structure; slightly hard, friable. slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; few fine firm peds or concretions; strongly acid (pH 5.3); abrupt smooth boundary. (7 to 9 inches thick)

Bwl--8 to 13 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine firm peds or concretions; medium acid (pH 5.6); clear smooth boundary. (5 to 8 inches thick)

Bw2--13 to 16 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; common fine distinct yellowish red (5YR 4/6) and few fine faint grayish brown (10YR 5/2)

pores; few fine black stains; medium acid (pH 5.7); clear wavy boundary. (12 to 14 inches thick)

 $28 \times 3--39$  to 60 Inches; variegated brown (10YR 5/3), yellowish brown (10YR 5/6), yellowish red (5YR 4/6) and pinkish gray (5YR 6/2) silt loam with light brownish gray (10YR 6/2), light yellowish brown (10YR 6/4) and very pale brown (10YR 7/3) streaks in fractures; massive; firm, brittle, hard. slightly sticky and slightly plastic; many very fine and few medium tubular pores; few very fine black stains; slightly acid (pH 6.1).

TYPE LOCATION: Multnomh County, Oregon; Salquist Road; SW1/4 SE1/4 NW1/4 section 13, T. 1 S., R. 3 E.

RANGE IN CHARACTERISTICS: The mean annual soil temperature is 54 to 56 degrees F. The soils are usually moist but are dry throughout between depths of 4 and 12 inches for more than 45 consecutive days during the period of 120 days following the summer solstice. Depth to the fragipan is 15 to 24 inches. Depth to bedrock is more than 5 feet.

The A horizon has chroma of 2 or 3 moist and dry.

The Bw horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry and chroma of 3 or 4 moist and dry. It has few faint and distinct mottles at depths between 12 inches and the fragipan. This horizon is silt loam and has more than 18 percent clay on the basis of 15 bar water of 9 or 10 percent.

The fragipan has variegated colors, distinct high or low chroma mottles and tongues or coatings with chroma of 2. It has massive, prismatic or platy structure and 15 firm or very firm

COMPETING SERIES: These are the Glohm and Kinton series. Glohm soils are moderately well drained with a udic moisture regime and are 20 to 40 inches deep to a fragipan. Kinton soils lack mottles with chroma of 2 above 30 inches.

GEOGRAPHIC SETTING: Powell soils are on smooth terraces at elevations at 300 to 600 feet. Slopes range from 0 to 30 percent. The soils formed in loess over old alluvium The climate is humid. The mean January temperature is about 39 degrees F., the mean July temperature is about 67 degrees F., and the mean annual temperature Is about 52 degrees F. The frost-free season is about 165 to 210 days. The mean annual precipitation ranges from 50 to 60 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cornelius and Wollent soils. Cornelius soils have an argillic horizon, are moderately well drained and are 30 or 40 inches deep to the fragipan. Wollent soils are poorly drianed and lack a fragipan.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained; slow to medium runoff; slow permeability.

USE AND VEGETATION: Berries, truck crops, nursery stock, small grain, hay and pasture are the major crops. Native vegetation is Douglas-fir, western redcedar, red alder, grand fir. bigleaf maple, willow, rose, salal, vine maple, common snowberry, grasses and forbs.

DISTRIBUTION AND EXTENT: Northwestern Oregon and southwestern Washington. The series is inextensive.

SERIES ESTABLISHED: Nultnomah County, Oregon, 1919.

ADDITIONAL DATA: Characterization data for two pedons (\$70-0reg-26-1 and 2) reported in Riverside Soil Survey Laboratory computer printout for soils sampled in Multnomah, Clackamas and Washington Counties, Oregon, 1971.

NATIONAL COOPERATIVE SOIL SURVEY USA

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SELL NC. 570 CRE . 26- 2 SIMPLE NO. 0 487-0 492 MULTNOMAH
      SOIL SERIES POLELL
                                                                                                  AREA
      SOIL FAMILY TYPIC FRAGIOCHREPT, FINE SILTY, MIXED, MESIC
                                                                          RIVERSIDE SOIL SURVEY LABORATORY
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Established Series Rev. AON/TDT 11/81

#### **BULL RUN SERIES**

The Bull Run series consists of deep, well drained soils that formed in silty materials high in ash. Bull Run soils are-on hill slopes in the lower valleys in mountainous areas and have slopes of 3 to 80 percent. The mean annual precipitation is about 85 inches and the mean annual temperature is about 51 degrees F.

TAXONOMIC CLASS: Medlal, mesic Unbric Vitrandepts.

TYPICAL PEDON: Bull Run silt loam, forested. (Colors are for mois soil unless otherwise noted.)

O--l inch to 0; twigs, needles, leaves, cones, etc.

A--0 to 3 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; strong very fine and fine subangular blocky and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine irregular and tubular pores; many fine and medium roots; medium acid (pH 5.6); clear wavy boundary. (2 to 12 inches thick)

AR--3 to 7 inches; very dark grayish brown ( $10 \mbox{YR} 3/2$ ) silt loam, brown ( $10 \mbox{YR} 5/3$ ) dry; strong very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and very fine irregular and tubular pores: medium acid (pH 5.7); clear wavy boundary. (0 to 7 inches thick)

BA--7 to 13 inches; dark yellowish brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate very fine, fine and medium subangular blocky structure; soft, friable. slightly sticky and slightly plastic; many fine, medium and coarse roots; many fine and very fine irregular and tubular pores; medium acid (pH 5.7); gradual wavy boundary. (4 to 18 inches thick)

Bw--13 to 23 inches; dark yellowish brown (10YR 3/4) silt loam, yellowish brown (10YR 5/4) dry; weak very fine, fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine, medium and coarse roots; many fine and very fine irregular and tubular pores; medium acid (pH 5.8); clear wavy boundary. (6 to 18 inches thick)

BC--23 to 36 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; variegated with 30 percent dark yellowish brown (10YR 3/4) weak; very fine, fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine, medium and coarse roots; many fine and very fine tubular

- . and irregular pores; medium acid (pH 5.7); clear wavy boundary. (0 to 3 feet thick)
  - Cl--36 to 54 inches; dark yellowish brown (10YR4/4) silt loam, light yellowish brown (10YR6/4) dry; massive; soft, friable, slightly sticky and slightly plastic; few fine, medium and coarse roots; many fine and very fine irregular pores; medium acid (pH 5.8); gradual wavy boundary. (1 to many feet thick)
  - C2--54 to 73 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (IOYR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; trace of coarse fragments; few fine, medium and coarse roots; many very fine and irregular pores; medium acid (pH 5.8).

TYPE LOCATION: Clackmas County, Oregon; along the south side Bull Run River Road, south of Bull Run Reservoir No. 2; NW1/4 NW1/4 section 36, T. 1 S., R. 5 E., W M

RANGE IN CHARACTERISTICS: The mean annual soil temperature ranges from 47 to 54 degrees F. The soils have a udic moisture regime but have a short dry period of less than 45 consecutive days during the summer. Thickness of the solum ranges from 30 to over 60 inches. Depth to bedrock is 60 inches or more. The 60-inch profile is silt loam with measured clay of about 12 to 18 percent, a ratio of clay to 15-bar water of 1.0 or less, and a bulk densfty of about .70 to .85 gm/cc in the upper 2 feet of the profile. They have an average 15-bar water retention of about 15 to 20 percent in the 10 to 40 inch control section. The soils are medium to strongly acid. The unbric epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 moist, 3 through 5 dry and chroma of 2 moist and dry. It has moderate or strong fine and very fine subangular blocky structure.

The B horizon has hue of 10YR or 7.5YR, value closet to 3 in upper part and 3 or 4 in the lower part when moist and 5 or 6 dry, and chroma of 3 in the upper and 4 through 6 in the lower part moist, dry. It has weak or moderate very fine to medium subangular blocky structure.

The C horizon is mostly silt loam but gravelly glacial till is below depth of 40 inches in some pedons.

COMPETING SERIES: These are the Parkdale and Yacolt series. Parkdale soils formed in ash and weathered pumice, have Xeric moisture regime and are slightly acid to neutral. Yacolt soils have more than 15 percent rock fragments in the control section and formed mostly in ash and pumice.

GEOGRAPHIC SETTING: Bull Run soils are on hill slopes in lower valleys of mountainous areas at elevations of 100 to 2,500 feet. Slopes range from 3 to 80 percent. The soils formed In loess with some admixture of ash. The climate 15 humid. The mean annual precipitation ranges from 60 to 105 inches. The mean annual temperature ranges from 48 to 54

degrees F. The average January temperature is 37 degrees F. and the average July temperature is 65 degrees F. The frost-free period is 100 to 200 days.

GEOGRAPHICALLY ASSOCIATED SOILS: Theses are the Ashcoff, Hoodview and the Wahkeena soils. These soils lack the dominance of pyroclastic materials and amorphous clays and have more than 35 percent rock fragments in the 10 to 40 inch control section.

DRAINAGE AND PERMEABILITY: Well drained; slow to rapid runoff; moderate permeability.

USE AND VEGETATION: Timber production, watershed, recreation and wildlife. Dominant overstory vegetation is Douglas-fir, western hemlock, western redcedar. and red alder; dominant understory vegetation is western swordfern, Oregon oxalis, and vine maple.

DISTRIBUTION AND EXTENT: Lower valleys of the Cascade Mountains in northwest Oregon. The series is of moderate extent.

SERIES ESTABLISHED: Clackanas County, Oregon, 1975.

ADDITIONAL DATA: Characterization data on 3 profiles (FS610reg-045-4 (1-4), FS620reg-045-8(1-7), and FS640reg-045(43) by the Oregon State University. Unpublished.

NATIONAL COOPERATIVE SOIL SURVEY U. S. A.

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Established Series Rev. AON/GLG 12/81

THADER SERIES

The Thader series consists of moderately deep, well drained soils that formed in colluvium and residuum weathered from basalt and andesite. Thader soils are in mountainous areas and have slopes of 0 to 90 percent. The mean annual precipitation is about 125 inches and the mean annual air temperature is about 42 degrees F.

TAXONOHIC CLASS: Loamy-skeletal, mixed Humic Cryorthods.

TYPICAL PEOON: Thader very cobbly loam, forested. (Colors are for moist soil unless otherwise noted.)

- 0l--5 to 4 inches; loose litter of needles, twigs. cones, leaves, etc.
- 02--4 inches to 0; black (10YR2/1) decomposing organic matter; many roots; extremely acid (pH 4.0); abrupt wavy boundary.
- E--U to 2 inches; dark gray (10YR 4/1) very cobbly fine sandy loam yray (10YR G/1) dry; massive; soft, friable, nonsticky and slightly plastic; many fine medium and coarse roots; many fine and very fine irregular pores; 50 percent cobbles and gravel; extremely acid (pH 4.3); abrupt wavy boundary. (1 to 5 inches thick)
- Bhsl--2 to 4 inches; dark reddish brown (5VR 2/2) very cobbly loam brown and dark brown (7.5YR 4/4 and 3/3) dry; massive; hard, firm, nonsticky and slightly plastic; common fine, medium and coarse roots; many fine and very fine irregular pores; 60 percent angular stones, cobbles, and gravel; very strongly acid (pH 5.0): abrupt wavy boundary resulting in this horizon being intermittent (30 percent present). (0 to 5 inches thick)
- Bhs?r-4 to 17 inches; dark brown (7.5YR 3/3) very cobbly silt loam, brown (7.5YR 4/4) dry and crushed; variegated with dark yellowish brown (10YR 4/4) and dark reddish brown (5YR 3/4); weak very fine and fine subangular blocky and granular structure; slightly hard, friable and firm, slightly sticky and slightly plastic; many fine medium and coarse roots; many fine and very fine tubular and irregular pores; 70 percent stones, cobbles and gravel; strongly acid (ptl 5.1); clear wavy boundary. (10 to 20 inches thick)
- BC--17 to 28 inches; dark brown (7.5YR 4/4) very cobbly silt loam light yellowish brown (10YR 6/4) dry and crushed; variegated with dark yellowish brown (10YR 4/4), brown (10YR 5/3) and grayish brown (10YR 5/2); massive; slightly hard, slightly firm, slightly sticky and slightly plastic; few fine, medium and coarse roots; many fine and very fine irregular pores; 70 percent angular stones, cobbles and gravel strongly acid (pH 5.4); abrupt wavy boundary. (7 to 20 inches thick)

#### THADER SERIES CONTINUED

2R-28 inches; fractured basalt and andesite. TYPE 10CATION: Clackamas County, Oregon; 100 feet northeast of the Bull Run Lake Road, 1.7 miles southwest of the switchback above Bull Run Lake; NE1/4 SW1/4 section 29, 7.15., R.8E., W.M.

RANGE IN CHARACTERISTICS: The soils are usually moist and are dry for less than 45 consecutive days between depths of 8 to 24 inches. The mean annual soil temperature ranges from 38 degrees to 45 degrees F. The mean summer soil temperature is less than 47 degrees F. with an 0 horizon. Depth to bedrock ranges from 20 to 40 inches.

The E horizon has value of 4 or 5 moist, 6 or 7 dry, and chroma of 1 or less. It is fine sandy loam or loam These are 30 to 50 percent cobbles and 15 to 35 percent pebbles.

The Bhs horizon has hue of  $2.5 \, \text{KR}$  or  $5 \, \text{KR}$  and value of 2 or 3 moist and 4, 5 and 6 dry. The Bhs horizon is dominantly dark brown  $(7.5 \, \text{KR} \, 3/3, 3/2)$ , but it is variegated with colors in hue of  $10 \, \text{KR}$  through  $5 \, \text{KR}$ , value of 3 or 4 moist and chroma of 2 through 4. Organic matter in the upper 4 inches of the Bhs horizon is more than 10 percent. The Bhs horizon is loam or silt loam and has 45 to 70 percent rock fragments.

The C horizon, where present, is similar in color to the BC horizon hut without the variegations.

COMPETING SERIES: There are no competing series in this family. Similar soils include Lastance series. Lastance soils are more than 40 inches deep to bedrock.

GEOGRAPHIC SETTING: The Thader soils are on major ridges in the Cascade Mountains between elevations of 3,000 and 5,000 feet. Slopes range from 0 to 90 percent. The soil formed in colluvium and residuum weathered from olivine basalts and olivine-bearing andesites of the Cascade Andesite Formation. The climate is humid. The mean annual precipitation ranges from 90 to 145 inches, falling as rain in the early autumn and late spring, and snow in the late autumn, winter and early spring. Rainfall amounts are relatively low in the summer. The average January temperature is 29 degrees F. The average July temperature is 56 degrees F. The mean annual air temperature is 38 degrees to 45 degrees F. The frost-free period is 10 to 30 days.

GEOGRAPIIICALLY ASSOCIATED SOILS: These are the Goodlow, Kinzel and Oneonta soils and the competing Lastance soils. Goodlow, Kinzel and Oneonta soils lack spodic horizons and are deeper than 40 inches to bedrock.

DRAINAGE AND PERMEABILITY: Well drained; slow to rapid runoff; moderately rapid permeability.

USE AND VEGETATION: The primary uses of the Thader soils are for timber production and for recreation and wildlife. Overstory vegetation

# THADER SERIES CONTINUED

is Douglas-fir, hemlock, silver fir, noble fir, and western redcedar. The dominant understory vegetation is huckleberry, rhododendron, and beargrass.

DISTRIBUTION AND EXTENT: Cascade Mountains of northwest Oregon. The series is of moderate extent.

SERIES ESTABLISHED: Multnomah County, Oregon (Bull Run, Sandy Area), 1976.

ADDITIONAL DATA: Characterization data for one pedon (FS62-Ore-045-15 (I-6)) by Oregon State University. (Unpublished)

Mational Cooperative Soil Survey U. s. A.

26

Thader Cobbly Loam Loamy - Skeletal, mixed Humic Cryorthods Type Location - FS 1962

Hori-	Depth	pH at	Free Iron Fe (Per-	Organic Matter (Per-	Organic Carbon (Per-	Total Nitro- gen (Per-	C/N	Phos-	Cation Exchange Capacity		tractal	ole Car 00g.)	tions	Base Satura- tion (Per-
zon	(Inches)	1:1 ratio	cent)	cent)	cent)	cent)	Ratio	<u>(ppm)</u>	(meq./100g)	_ Ca	Mg	K	Na	cent)
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B22hir	3 - 1 7	5.1	3.76	14.3	8.3	.23	36	2	45	0.2	0.2	0.22	0.24	2
В3	17-28	5.4	2.36	3.6	2.1	.08	27	2	23	0.4	0.2	0.13	0.22	4

			Particles 2mm and smaller in size Sand Size Fractions									
		Texture				Very fine	Fine	Medium	Coarse	Very Coarse		
Hori- zon	Depth (Inches)	Class (field)	Clay (%)	Slit (%)	Sand (%)	sand (%)	sand (%)	sand (%)	sand (%)	sand (%)		
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B3ir	17-26	vcobgl	5	60	35	13	9	4	4	2		

LOCATION PARKDALE

Established Series Rev. DFA/AON

TYPE LOCATION: Hood River County, Oregon; 130 feet west and 50 feet south of east quarter corner in the NE1/4 NE1/4 NE1/4 section 6, T. 1 s., R. 10 E.

RANGE IN CHARACTERISTICS: The soils are usually moist and are dry between depths of 8 to 24 inches for 45 days or more during the summer. The mean annual soil temperature ranges from 47 to 51 degrees F. The soils are slightly acid to neutral. The solum is 7 to 20 inches thick. The control section lacks rock fragments. The umbric epipedon is 7 to 12 inches thick.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 moist, 4 or 5 dry, and chroma of 2 or 3 moist and dry. It has 5 to 30 percent "shot", 1 to 5 mm in diameter.

The B2 or AC horizon has hue of 10YR or 7.5YR, value of 4 or 5 moist and 5 through 7 dry. It is loam or silt loam and has 4 to 10 percent clay. This horizon usually has weak granular or very fine subangular blocky structure but is massive and more like a C horizon in some pedons.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 moist and chroma of 4 through 6 moist and dry.

COMPETING SERIES: These are the Chemawa. Cinebar, Crater Lake, Forward, Stabler. loutle, and Yacolt series. Chemawa, Crater Lake, Forward, Stabler, and Toutle soils have ochric epipedons. Cinebar soils have sola thicker than 40 inches and are medium to very strongly acid. Yacolt soils have more than 15 percent rock fragments in the control section and are medium to strongly acid.

GEOGRAPHIC SETTING: Parkdale soils have nearly level to steep upland slopes at elevations of 1.000 to 2,500 feet. These soils formed in deep mud flows high in pyroclastic materials. The mean annual precipitation is 35 to 50 inches. The mean annual temperature is about 45 to 49 degrees F., the mean January temperature is about 29 to 33 degrees F., and the mean July temperature is about 61 to 65 degrees F. The frost-free (32 degrees F.) season is 100 to 120 days and for 28 degrees F. is 160 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Culbertson and Dee soils. Culbertson soils are low in pyroclastic materials. Dee soils are mottled and somewhat poorly drained.

DRAINAGE AND PERMEABILITY: Well drained; slow to medium runoff; moderate permeability.

USE AND VEGETATION: Orchard crops. Native vegetation is mainly Douglas-fir, ponderosa pine, grand pine, forbs, and shrubs.

DISTRIBUTION AND EXTENT: Uplands of north-central Oregon and south-central Washington. The series is of moderate extent.

SERIES ESTABLISHED: Hood River-White Salmon River Area, Oregon-Washington, 1972.

REMARKS: The Parkdale soils were formerly classified as Regosols.

ADDITIONAL DATA: Characterization data on 2 profiles (\$610reg-14-9 and \$610reg-14-10) reported in Riverside Soil Survey Laboratory Report for soils sampled in Hood River County, Oregon, October. 1961.

NATIONAL COOPERATIVE SOIL SURVEY U. S. A.

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FIELD TOUR

June 25, 1986

Summary Information Prepared

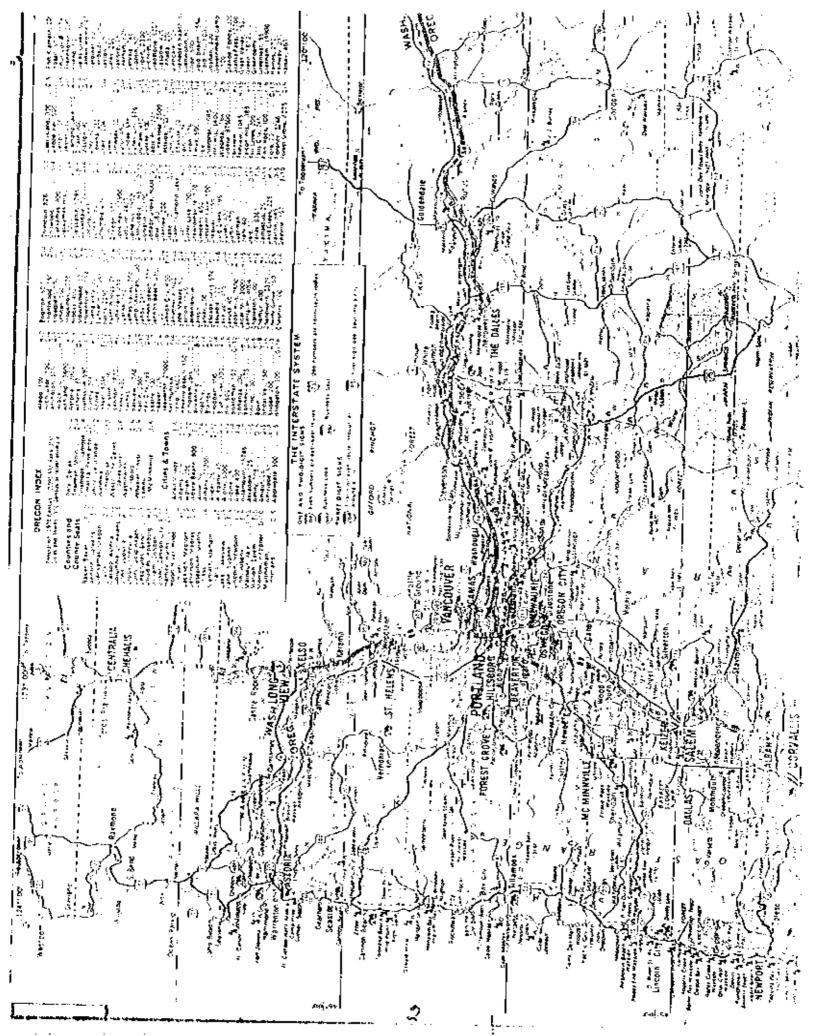
by

Robert T. Menrisse Leader, Soils Group Pacific Northwest Region USDA Forest Service

# Tour Guides:

George Green, Assistant State Soil Scientist, USDA-SCS, Portland Jerry Simonson, Professor, Soils, Oregon Ag. Exp. Stn., OSU, Corvallis Jerry Latshaw, State Soil Scientists, USDA-SCS, Portland Bob Heurisse, Leader Soils Group, USDA-Forest Service, Portland





# GEOLOGY OF THE CASCADE RANGE IN OREGON AND SOUTHERN WASHINGTON 11

The Cascade Range, part of a continuous mountain chalm near the western margin of the North American continent, extends from Lassen Peak in northern California through Oregon and Washington. Through the central part to Oregon and in southern Washington, the Cascade Range is divided into two distinct provinces: the peologically young high Cascades and the older Western Cascades. Both belts are mostly of volcanic extrusive origin; both include subordinate amounts of near surface intrusive rocks, some continental sedimentary deposits, and sufficial deposits related to stream or glacial crosion and to several kinds of mass wasting.

Physiographically, the range is characterized by a long western slopethat descends irregularly to low valleys inthe Willamette-Puget lowland or coalesces locally with the Coast Range or Klamath Mountains on the west. The fairly abrupt eastern slope descends t" lavaplateaus east of the Cascades. The higher eastern part of the range consists of a narrow volcanic plateau at average elevations of about 5,000 to 6,000 feet. It is surmounted by a number of steep-sided volcanic cones including Mt. Rainier (14,408 feet), Elt. Adams, and Mt. St. Helens in Washington; and Mt. Hood (11,235 feet), Mt. Jefferson, Three Sisters, and Mt. McLoughlin in Oregon. One of the large ancestral cones, Mt. Mazama, erupted many cubic miles of

Surficial deposits, composed almost entirely of volcanic debris, are related to glacial and stream crosion and to mass wasting of older rocks. Some surficial deposits have resulted from comparatively tecent cruptions of volcanic ash.

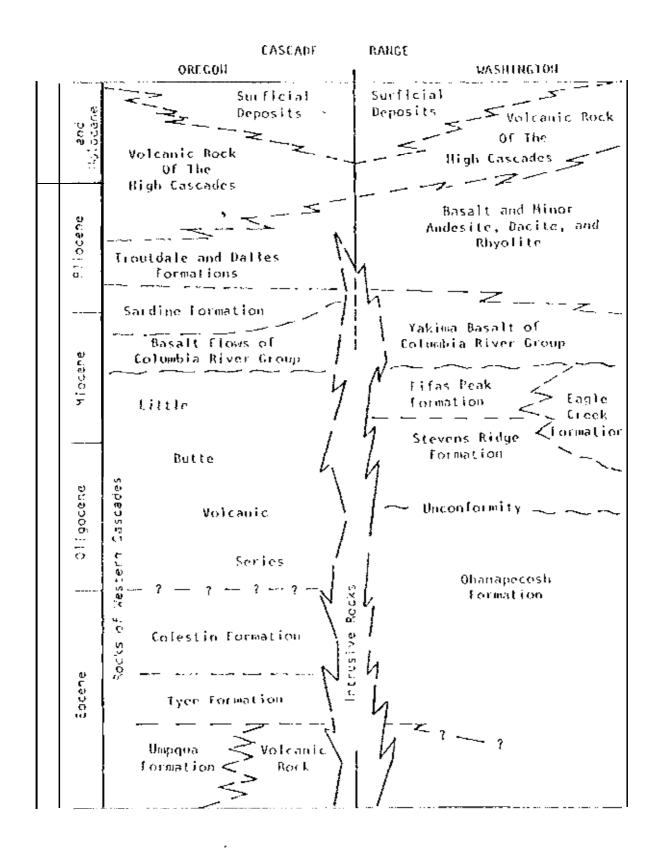


Figure 1 Rock formational units in the Cascade Range, Oregon and Washington, arranged to show their time sequence relations.

Avaianches, rockfalls, and landslides from oversteepened slopes also have contributed to crosion all along the Cascade Range. Large mudflows, composed of unsorted masses of angular to subrounded fragments suspended in water, originated high on Cascade Peaks and poured down glacial and stream valleys.

# Comorphic Surfaces 2/

Local geomorphic surfaces were mapped on high-altitude aerial photographs. The surfaces are named for areas where they are particularly well expressed. The surfaces, in order of focreasing age, are Horseshoe, Ingram, Luckiamute, Winkle, Champeeg, Senecal, Bethel, Dolph, and Eola. The steep, mountainous topography is called the Looney Unit but fits no particular space of time. The surfaces and some features are as follows:

Surface Horsesboo Lugram Winkle	Age (yrs.) Very recent 550-3,290 Mid.to early Holocene (5,250-12,240)	Pos i tionand/or Elevation (ft.) f Loodplains <20 floodplains 20-50 ahandonedfloodplains		Texture s, is gl, sil, sich si, c
Champoog Senecal Bothol Botpb	Late Pleistocene Late Pleistocene Late Pleistocene Mid Pleistocene	terraces terrace remnants rolling hills terrace/pediment	100-200 200-300 300-500 450-600	g, ch, s si, c si, c weathered gravel Saprolite, clay
Eo∤a	Early Pleistocene	erosional remnant roundedhi 1 Is	silt, loess	

<sup>2/</sup> From Multnomah County soil survey. Material prepared by Dr. R.H. Parsons, Research Soil Scientist (deceased), Soil Conservation Service.

CLIMATE OF MULTHOMAR COUNTY AND THE ME. HOOD NATIONAL FOREST AREA!

Air flow isprimarily easterly from the Pacific Ocean. Normally, warm moist air moves eastward towardthe Cascade Crest. As this air rises, it cools and drops rain along the windward slopes. The descending air on the leeward slopes warms by compression, and precipitation decreases rapidly. Average annual precipitation on the west slopes ranges from about 38 inches at Portland, increases to about 60 inches at Estacada to in excess of 130 inches northwest of Mt. flood. It then decreases to about 20 inches near Rock Creek Reservoir on the eastside of the Forest. (see table)

During an average winter, snowfallranges from near zero at lower elevations to over 300 LO 500 inches near the crest. snow usually covers the ground from mid-December L o late February or March at lower elevations. AL highelevations snow can be expected Lo remain on the ground from October to June. Average, maximum temperatures range from near 25 Lo 35°F. in the winter. Average minimum temperatures are from 5 to 15°F. Temperatures as low as -20°F. are not uncommon.

Warmer and drierair masses generally begin in May, peak in July and August, and continue in late August and early September. Thunderstorms can be expected during that period.

Average, maximum summer temperatures are in the 60's and 70's with occasional 801 days at higher elevations. At lower elevations, average maximum temperatures range from 70 to 80°F, with occasional temperatures of 100°F. Minimums at higher elevations are in the mid 40's and 50's and 50's and 60's at lower elevations.

Tablel. Mean annual precipitation for nine recording stations for the period 1967 to 1977 or 1951 to 1976\*

Station	Elevation (ft.)	Mean Annual Precip. (inches)
Government Camp	3980	86.24
Friend	2440	15.76
Parkdale	1940	45.01
Dufer	1330	12.47
Detroft	1300	87.86
Three Lynx	1120	72.93
Portland Headworks	748	83.05
Oregon City	167	48.00
Bouneville Dam	60	78.85
Portland*	50	37.5s

Summarized from Mt. flood NationalForest Soil Resource Inventory and Report, USDA, Forest Service, Pacific Northwest Region, 1979; and Soil Survey of Multinomah county, Oregon 1983, USDA, Soil Conservation Service and Forest Service in cooperation with Oregon Agricultural Experiment Station.

#### Soil Moisture and Temperature Regimes

Two soll moisture regimes occur in the Multuomah County and Mt. Bood National Forest area. They are Xeric at the lower elevations and Udic at higher elevations. In this area, the Xeric regime is generally associated with mean annual precipitation of less than 60 inches and the Udic regime greater than 60 inches precipitation.

Three temperature regimes are present. They are Mesic, Frigid, and Gryle. Mesic regimes usually occur at elevations below 1500 to 1600 feet in this area. Frigid regimes occupy a narrow band between 1500 and 2800 feet on north slopes and 1600 to 3000 feet on south slopes. Cryle regimes occur above 2800 to 3000 feet elevation.

# NATURAL VEGETATION OF THE NORTHERN WILLAMETTE VALLEY AND NORTHERN OREGON CASCADES 1/2/

# Willamette Valley

Riparian Communities - Typical riparian forests in the northern Willamette Valley in the lower Willamette and Columbia Rivers are dominated by black cottonwood. Associated species include rigid willow, Scouler's willow, red wi I low and sof t leaved willow. Oregon ash is characteristic on seasonally flooded and swampy hatitat. Rig leaf maple also is common as Is red alder.

Valley Floor and Foothills-Before settlement, much of the Willamtte Valley was occupied by prairie and oak savannas. These were created and maintained by fires probably used by native Americans. Douglas-fir is the dominant evergreen tree in the remnant forest areas. Oregon white oak, big leaf maple and pacific madrone are common broadleaf species. Common understory species include poison oak, dogwood, oceanspray and western hazel. Swordfern, oxalis and white hawk weed are common in the forest floor.

#### Cascades

Four conifer series span the forested portion of the Oregon Cascades. The western hemlock series dominates relatively warm moist sites below about 3,000 feet elevation west of the Cascade Crest. Canopy species include Douglas-fir, western hemlock, western red cedar and, on recently disturbed sites, red alder. Understory species reflect relative moisture and temperature conditions. Devil'sclub, salmonberry, oxalis and swordfern indicate abundant moisture through the growing season and, generally, high site productivity. Oregongrape and vanilla leaf dominate more well-drained sites. Rhododendron is most abundant on poorer sites with thin, rocky soils.

The Pacific silver fir series occurs in a hand between about 3,000 feet and 5,000 feet elevation west of the Cascade Crest and slips east of the Crest down to about 4,500 feet. At lower elevations, the Pacific silver fir and western hemlock series overlap. This series indicates cooler climatic conditions, usual ly with substantial winter snowpacks. Pacific silver fir, Douglas-fir,

<sup>1/</sup> From: Franklin, J. and C.P. Dyrness 1973, Natural Vegetation of Oregon and Washington, USDA, Cen. Tech. Report, PNW 8.

<sup>2/</sup> Information derived from R-h Ecology Program - Miles Hemstrom, Area Ecologist, Willamette and Siuslaw National Forests and Nancy Halvorson, Area Ecologist, Mt. Hood and Gifford Pinchot National Forests.

westernhemlock, noble fir, western while pine, and mountain hemlock are the major canopy species. Important understory species include Oregongrape, vine maple, salal and, on poorer sites, rhododendron. At upper elevations, big huckleberry and heargrass become dominant species. Timber management is more difficult in the Pacific silver flr zone. Deep snowpacks, short growing seasons, growing season frost and poor soils contribute to difficult regeneration and relatively slow tree growth rates.

At the upper limit of closed canopy forest (to about 6,000 feet) mountain hemlock is the major climax species. Bighuckleberry, grouse huckleberry and beargrass characterize the understory. Snowpacks are deep, growing seasons short and soils generally poor in this zone. Opening fillin very slowly, usually with naturally seeded lodgepole pine and white pine or advanced regeneration of noble fir, Pacific silver fir and mountain hemlock.

East of the Cascade Cresl, below 4,500 feet, grand fir and, on drier sites, bouglas-firare the major climax species in areas that support forests. Canopy species include Ponderosa pine, we stern larch, Douglas-fir, and grand fir. Lodgepole pine occurs in extensive stands on deep volcanic ash soils.

Chinquapin, vine maple, service herry, rose, vanilla leaf and grasses dominate the understory in more moist areas. Hitterbrush and sagebrush are important on drier sites. Regeneration can be difficult, although ponderosapine may do well. Growth rates are usually lowerthan west of the Cascade Crest.

# Soils

The soils of Multnomah County, ML. Hood National. Forest, and Hood River County areas are described inthefollowing publications:

Multnomah County - USDA, Soil Conservation Service, Forest Service and Oregon Agricultural Experiment Station by George Green, Soil Conservation Service Published 1983. Map Scale 1:20,000

Mt. Hood National Forest, Soil Resource Inventory, Forest Service, USDA by Steven Howes, Forest Service, Published 1979, Map Scale 1:63,000

Hood River County Area, USDA Soil Conservation Service and Oregon Agricultural Experiment Station by George Green, Soil Conservation Service, Published 1981, Map Scale 1:20,000.

some of the more common or representative soils, their general characteristics, features and uses are briefly discussed. They are described in sequence from lowest elevation near Portland and proceeding eastward across the Cascades lo the flood River Valley.

Sauvie Series - Fine-silty, mixed mesic Fluvaquentic Haplaquolls. Very deep, poorly drained soils on flood plains. They are on the Ingram surface at elevation of 10 to 20 feet.

Principal Use and Management -Wildlife habitat. When protected and drained, it is productive for sweet corn, row crops, nursery crops, grasses, and grain crops.

Multnomah Series - Fine-loamy over sandy or sandy skeletal mixed mesic Dystric Xerochrepts, very deep, well drained soils on terrace. They are on the Champoeg surface at elevations of 150 to 400 feet.

PrincipalUse and Management - Berries, grains, vegetables, nursery stock and pasture. Irrigated For maximum production. Berries respond to N, P, K, S and sometimes B. Also used for urban development with no major limitations for homesi tes. Ground water may be contaminated from septic tank absorption fields.

Powell Series (Stop 1) - Fine-silty, mixed, mesic Typic Fragiochrepts. Deep, somewhat poorly drained soils on broad, high terraces. They are on the Bethel surface at elevations of 300 to 600 feet.

Principal Use and Management I- When drained, major crops are grain, berries, vegetables, nursery stock, hay and pasture. Summer irrigation

Zygore Series - Medial-skeletal, frigid Andic Haplumbrepts. Deep, well drained soils on mountainous slopes. Formed in colluvium and glacial till from basalt and andesite at elevations of 1500 to 3000 feet. Principal use and management - similar to Bull Run. Site index for Douglas-fir is 160 to 170. Plant available water capacity is 4 to 6 inches. Water holding capacity is 21 to 26 inches.

Thadr Series (Stop 3) - Loamy-skeletal, mixed. Humic Cryorthods.

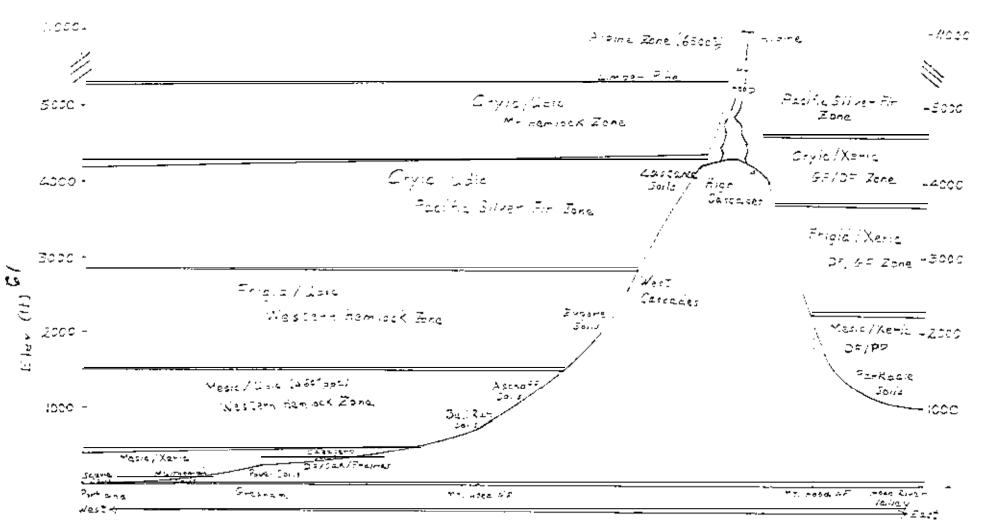
Deep, well drained soils on broad ridges in mountainous areas. Formed in colluvium and glacial till from andesite and basalt mixed with volcanic ash.

Principal Use and Management - Used mostly for timber production, watershed management and wildlife habitat. Managed mostly for noble fir, Pacific silver fir and western hemlock. 'Site index for noble fir is 50 to 70. At site index of 52, 70 year old stands are capable of producing 14,300 bd. ft/ac. Cold soils limit productivity and plant succession is slow when disturbed.

Parkdale <u>Series</u> - (Stop 2) - Medial, mesic, Umbric Vitrandapts. Deep, well drained soils formed in deep mudflows high in pyroclastic materials. They are at elevations of 1000 to 2500 feet.

Principal Use and Management - Used mostly for apple and pear orchards. Some are used for timber production. Dominant species are Douglas-fir. Some grand fir and ponderosa pine also are grown. Site index for Douglas-fir averages about 130.

The orchards are largely Delicious and Newton apples and Bartlett, Bosc and d'Angou pears. High level management yields 850 boxes/ac apples and 950 boxes/ac. pears. orchard trees respond to N. Sometimes, magnesium, boron or zinc are applied as foliar sprays.



Sell moisture and temperature regimes, representative soils and regetation foret on an fact west transect from fort and in the williamete Valley derost the Cascades to the Hold Rivar Valley.

(Seale limin & slamb)

Rtx.

12/81 OR

LOCATION POWELL

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Established Series Rev. RV/L/AON 12/81

#### **POWELL SERIES**

The Powell series consists of deep, somewhat poorly drained soils that formed in silty materials over old silty alluvium Powell soils are on broad high terraces and have \$lopes of 0 to 30 percent. The mean annual precipitation is 55 inches and the mean annual air temperature is about 52 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, mesic Typic Fragiochrepts.

TYPICAL PEDON: Powell silt loam, cultivated. (Colors are for moist soil unless otherwise noted.)

Ap--O to 8 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; few fine firm peds or concretions; strongly acid (pH 5.3); abrupt smooth boundary. (7 to 9 inches thick)

Bwl--8 to 13 inches; brown (10 YR 4/3) silt loam, pale brown (10 YR 6/3) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine firm peds or concretions; medium acid ( $p \parallel 5.6$ ); clear smooth boundary. (5 to 8 inches thick)

Bw2--13 to 16 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; common fine distinct yellowish red (5YR 4/6) and few fine faint grayish brown (10YR 5/2) mottles; moderate fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine firm peds or concretions; strongly acid (pH 5.5); abrupt wavy boundary. (3 to 10 inches thick)

 $28 \times 1-16$  to 25 inches; brown (10 YR 4/3) and dark yellowish brown (10 YR 4/4) silt loam, pale brown (10 YR 6/3) and light yellowish brown (10 YR 6/4) dry; many medium distinct light brownish gray (10 YR 6/2), grayish brown (10 YR 5/2) and reddish brown (5 YR 4/3, 4/4) mottles,; weak thin platy structure; firm, brittle, hard, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few fine and medium black stains; strongly acid (p H 5.4); clear wavy boundary. (8 to 10 inches thick)

 $28 \times 2--25$  to 39 inches; brown (10 YR 4/3) sflt loam, very pale brown (10 YR 7/3) dry; many fine distinct yellowish red(5 YR 5/6, 5/8) mottles; light brownish gray (10 YR 6/2) and grayish brown (10 YR 5/2) wedge-shaped silt coatings up to 1 inch thick on vertical faces of prisms; weak medium and coarse prismatic structure; firm, brittle, hard, slightly sticky and slightly plastic; few fine and common very fine tubular

pores; few fine black stains; medium acid (pH 5.7); clear wavy boundary. (12 to 14 inches thick)

28x3--39 to 60 inches; variegated brown (10YR 5/3), yellowish brown (10YR 5/6), yellowish red (5YR 4/6) and pinkish gray (5YR 6/2) silt loam with light brownishgray (10YR 6/2), light yellowish brown (10YR 6/4) and very pale brown (10YR 7/3) streaks in fractures; massive; firm, brittle, hard, slightly sticky and slightly plastic; many very fine and few medium tubular pores; few very fine black stains; slightly acid (pH 6.1).

TYPE LOCATION: Multnomah County. Oregon; Salquist Road; SW1/4 SE1/4 NW1/4 section 13, T. 1 S., R. 3 E.

RANGE IN CHARACTERISTICS: The mean annual soil temperature is 54 to 56 degrees F. The soils are usually moist but are dry throughout between depths of 4 and 12 inches for more than 45 consecutive days during the period of 120 days following the summer solstice. Depth to the fragipan is 15 to 24 inches. Depth to bedrock is more than 5 feet.

The A horizon has chroma of 2 or 3 moist and dry.

The Bw horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry and chroma of 3 or 4 moist and dry. It has few faint and distinct mottles at depths between 12 inches and the fragipan. This horizon is silt loam and has more than 18 percent clay on the basis of 15 bar water of 9 or 10 percent.

The fragfpan has variegated colors, distinct high or low chroma mottles and tongues or coatings with chroma of 2. It has massive, prismatic or platy structure and is firm or very firm

COMPETING SERIES: These are the Glohm and Kinton series. Glohm soils are moderately well drained with a udic moisture regime and are 20 to 40 inches deep to a fragipan. Kinton soils lack mottles with chroma of 2 above 30 inches.

GEOGRAPHIC SETTING: Powell soils are on smooth terraces at elevations at 300 to 600 feet. Slopes range from 0 to 30 percent. The soils formed in loess over old alluvium The climate is humid. The mean January temperature is about 39 degrees F., the mean July temperature is about 67 degrees F., and the mean annual temperature is about 52 degrees F. The frost-free season is about 165 to 210 days. The mean annual precipitation ranges from 50 to 60 Inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cornelius and Wollent soils. Cornelius soils have an argillic horizon, are moderately well drained and are 30 or 40 inches deep to the fragipan. Wollent soils are poorly drianed and lack a fragfpan.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained; slow to medium runoff; slow permeability.

USE AND VEGETATION: Berries, truck crops, nursery stock, small grain, hay and pasture are the major crops. Native vegetation is Douglas-fir, western redcedar, red alder, grand fir, bigleaf maple, willow, rose. salal, vine maple, common snowberry, grasses and forbs.

DISTRIBUTION AND EXTENT: Northwestern Oregon and southwestern Washington. The series is inextensive.

SERIES ESTABLISHED: Multnomh County, Oregon, 1919.

ADDITIONAL DATA: Characterization data for two pedons (\$70-0reg-26-1 and 2) reported in Riverside Soil Survey Laboratory computer printout for soils sampled in Multnomah, Clackamas and Washington Counties, Oregon, 1971.

NATIONAL **cooperative** SOIL **survey** USA

CONSECUTIVE PEDON NUMBER C 70 78 C H A R A C T E R I Z A T I O N DATA JULY 7 • 1972 SOIL SERIES POWELL SCIL NC. S70 ORE - 26- 2 SAMPLE NO. 0 487-0 492 MULTNOMAH AREA SOIL FAMILY TYPIC FRAGIOCHREPT, FINE SILTY, MIXED, MESIC RIVERSIDE SOIL SURVEY LABORATORY SIZE, CLASS AND PARTICLE DIAMETER (MM) 1818, 3A1 1A2A SAMPLE DEPTH HCRZ. SAND SILT CLAY VCS CS MS FS II III CX. OF 75- 20-5 5-2 24.6 67.0 8.4 20- 33 BZ1 0 489 33- 41 822 0 490 41- 63 CX1 0 491 63- 99 CX2 60. I -- A 0 492 99-175 CX3  $\mathbf{Q}^{-1}$ 1.43 1.54 1.00 33.7 25.5" 9.3( 2.5" HZO CA-2 MIN- 1/1 CL2:---- ---

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LOCATION BULL RUN

Established Series Rev. AON/TDT 11/81

### **BULL RUN SERIES**

The Bull Run series consists of deep, well drained soils that formed in silty materials high in ash. Bull Run soils are on hill slopes in the lower valleys in mountainous areas and have slopes of 3 to 80 percent. The mean annual precipitation is about 85 inches and the mean annual temperature is about 51 degrees  $\mathbb{F}$ .

TAXONOMIC CLASS: Medial, mesic Umbric Vitrandepts.

TYPICAL PEDON: Bull Run silt loam, forested. (Colors are for mois soil unless otherwise noted.)

- 0--1 inch to 0; twigs, needles, leaves, cones, etc.
- grayish brown (10YR 3/2) dry; strong very fine and fine subangular blocky and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine irregular and tubular pores; many fine and medium roots; medium acid (pH 5.6); clear wayy boundary. '(2 to 12 inches thick)
- AB--3 to 7 inches; very dark grayish brown (10YR3/2) silt loam, brown (10YR5/3) dry; strong very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and very fine irregular and tubular pores; medium acid (pH 5.7); clear wavy boundary. (0 to 7 inches thick)
- BA--7 to 13 inches; dark yellowish brown ( $10\mbox{YR}\,3/3$ ) silt loam, yellowish brown ( $10\mbox{YR}\,5/4$ ) dry; moderate very fine, fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many fine, medium and coarse roots; many fine and very fine irregular and tubular pores; medium acid (pH 5.7); gradual wavy boundary. (4 to 18 inches thick)
- Llw-13 to 23 inches; dark yellowish brown  $(10 \mbox{\sc R} 3/4)$  silt loam, yellowish brown  $(10 \mbox{\sc R} 5/4)$  dry; weak very fine, fine and medium subangular blocky structure; soft, very friable. slightly sticky and slightly plastic; many fine, medium and coarse roots; many fine and very fine irregular and tubular pores; medium acid (pH 5.8); clear wavy boundary. (6 to 18 inches thick)
- BC--23 to 36 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; variegated with 30 percent dark yellowish brown (10YR 3/4) weak; very fine, fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine, medium and coarse roots; many fine and very fine tubular

and irregular pores; medium acid (pH 5.7); clear wavy boundary. (0 to 3 feet thick)

Cl--36 to 54 inches; dark yellowish brown (10YR4/4) silt loam, light yellowish brown (10YR6/4) dry; massive; soft, friable, slightly sticky and slightly plastic; few fine, medium and coarse roots; many fine and very fine irregular pores; medium acid (pH 5.8); gradual wavy boundary. (1 to many feet thick)

C2--54 to 73 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; trace of coarse fragments; few fine, medium and coarse roots; many very fine and irregular pores; medium acid (pH 5.8).

TYPE LOCATION: Clackmas County, Oregon; along the south side Bull Run River Road, south of Bull Run Reservoir No. 2; NW1/4 NW1/4 section 36, T. 1 S., R. 5 E., W M.

RANGE IN CHARACTERISTICS: The mean annual soil temperature ranges from 47 to 54 degrees F. The soils have a udic moisture regime but have a short dry period of less than 45 consecutive days during the summer. Thickness of the solum ranges from 30 to over 60 inches. Depth to bedrock is 60 inches or more. The 60-inch profile is silt loam with measured clay of about 12 to 18 percent, a ratio of clay to 15-bar water of 1.0 or less, and a bulk density of about .70 to .85 gm/cc in the upper 2 feet of the profile. They have an average 15-bar water retention of about 15 to 20 percent in the 10 to 40 inch control section. The soils are medium to strongly acid. The unbric epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 moist, 3 through 5 dry and chroma of 2 moist and dry. It has moderate or strong fine and very fine subangular blocky structure.

The B horizon has hue of 10 YR or 7.5 YR, value closet to 3 in upper part and 3 or 4 in the lower part when moist and 5 or 6 dry, and chroma of 3 in the upper and 4 through 6 in the lower part moist, dry. It has weak or moderate very fine to medium subangular blocky structure.

The C horizon is mostly silt loam but gravelly glacial till is below depth of 40 inches in some pedons.

COMPETING SERIES: These are the Parkdale and Yacolt series. Parkdale soils formed in ash and weathered pumice, have Xeric moisture regime and are slightly acid to neutral. Yacolt soils have more than 15 percent rock fragments in the control section and formed mostly in ash and pumice.

GEOGRAPHIC SETTING: Bull Run soils are on hill slopes in lower valleys of mountainous areas at elevations of 100 to 2,500 feet. Slopes range from 3 to 80 percent. The soils formed in loess with some admixture of ash. The climate is humid. The mean annual precipitation ranges from 60 to 105 inches. The mean annual temperature ranges from 48 to 54

degrees F. The average January temperature is 37 degrees F., and the average July temperature is 65 degrees F. The frost-free period is 100 to 200 days.

GEOGRAPHICALLY ASSOCIATED SOILS: Theses are the Ashcoff, Hoodview and the Wahkeena soils. These soils lack the dominance of pyroclastic materials and amorphous clays and have more than 35 percent rock fragments in the 10 to 40 inch control section.

DRAINAGE AND PERMEABILITY: Well drained; slow to rapid runoff; moderate permeability.

USE AND VEGETATION: Timber production, watershed, recreation and wildlife. Dominant overstory vegetation is Douglas-fir, western hemlock, western redcedar, and red alder; dominant understory vegetation is western swordfern, Oregon oxalis, and vine maple.

DISTRIBUTION AND EXTENT: Lower valleys of the Cascade Mountains in northwest Oregon. The series is of moderate extent.

SERIES ESTABLISHED: Clackanas County, Oregon, 1975.

ADDITIONAL DATA: Characterization data on 3 profiles (FS610reg-045-4 (1-4), FS620reg-045-8(1-7), and FS640reg-045(43) by the Oregon State University. Unpublished.

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### LOCATION WADER

Established Series Rev. AON/GLG 12/81

THADER SERIES

The Thader series consists of moderately deep, well drained soils that formed in colluvium and residuum weathered from basalt and andesite. Thader soils are in mountainous areas and have slopes of 0 to 90 percent. The mean annual precipitation is about 125 inches and the mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed Humic Cryorthods.

TYPICAL PEDON: Thader very cobbly loam, forested. (Colors are for moist soil unless otherwise noted.)

- 01-5 to 4 inches; loose litter of needles, twigs, cones, leaves, etc.
- 02--4 inches to 0; black (10YR2/1) decomposing organic matter; many roots; extremely acid (pH 4.0); abrupt wavy boundary.
- E--0 to 2 inches; dark gray (10YR 4/1) very cobbly fine sandy loam gray (10YR 6/1) dry; massive; soft, friable, nonsticky and slightly plastic; many fine medium and coarse roots; many fine and very fine irregular pores; 50 percent cobbles and gravel; extremely acid (pH 4.3); abrupt wavy boundary. (1 to 5 inches thick)
- Bhsl--2 to 4 inches; dark reddish brown (5YR 2/2) very cobbly loam brown and dark brown (7.5YR 4/4 and 3/3) dry; massive; hard, firm, nonsticky and slightly plastic; common fine, medium and coarse roots; many fine and very fine irregular pores; 60 percent angular stones, cobbles, and gravel; very strongly acid (pH 5.0); abrupt wavy boundary resulting in this horizon being intermittent (30 percent present). (0 to 5 inches thick)
- Bhs2--4 to 17 inches; dark brown (7.5YR 3/3) very cobbly silt loam, brown (7.5YR 4/4) dry and crushed; variegated with dark yellowish brown (10YR 4/4) and dark reddish brown (5YR 3/4); weak very fine and fine subahgular blocky and granular structure; slightly hard, friable and firm, slightly sticky and slightly plastic; many fine medium and coarse roots; many fine and very fine tubular ahd irregular pores; 70 percent stones, cobbles and gravel; strongly acid (pH 5.1); clear wavy boundary. (10 to 20 inches thick)
- BC--17 to 28 inches; dark brown (7.5YR~4/4) very cobbly silt loam, light yellowish brown (10YR~6/4) dry and crushed; variegated with dark yellowish brown (10YR~4/4), brown (10YR~5/3) and grayish brown (10YR~5/2); massive; slightly hard, slightly firm, slightly sticky and slightly plastic; few fine, medium and coarse roots; many fine and very fine irregular pores; 70 percent angular stones, cobbles and gravel strongly acid

 $2R\mbox{--}28$  inches; fractured basalt and andesite. TYPE LOCATION: Clackamas County, Oregon; 100 feet northeast of the Bull Run Lake Road, 1.7 miles southwest of the switchback above Bull Run Lake; NE1/4 SW1/4 section 29, 7.15., R.BE., W M

RANGE IN CIIARACTCRISTICS: The soils are usually moist and are dry for less than 45 consecutive days between depths of 8 to 24 inches. The mean annual soil temperature ranges from 38 degrees to 45 degrees F. The mean summer soil temperature is less than 47 degrees F. with an 0 horizon. Depth to bedrock ranges from 20 to 40 inches.

The E horizon has value of 4 or 5 moist, 6 or 7 dry, and chroma of 1 or less. It is fine sandy loam or loam These are 30 to 50 percent cobbles and 15 to 35 percent pebbles.

The Bhs horizon has hue of 2.5YR or 5YR and value of 2 or 3 moist and 4, 5 and 6 dry. The Bhs horizon is dominantly dark brown (7.5YR 3/3, 3/2), but it is variegated with colors in hue of 10YR through 5YR, value of 3 or 4 moist and chroma of 2 through 4. Organic matter in the upper 4 inches of the Bhs horizon is more than 10 percent. The Bhs horizon is loam or silt loam and has 45 to 70 percent rock fragments.

The C horizon, where present, is similar in color to the BC horizon but without the variegations.

COMPETING SERIES: There are no competing series in this family. Similar soils include Lastance series. Lastance soils are more than 40 inches deep to bedrock.

GEOGRAPHIC SETTING: The Thader soils are on major ridges in the Cascade Mountains between elevations of 3,000 and 5,000 feet. Slopes range from 0 to 90 percent. The soil formed in colluvium and residuum weathered from olivine basalts and olivine-bearing andesites of the Cascade Andesite Formation. The climate is humid. The mean annual precipitation ranges from 90 to 145 inches, falling as rain in the early autumn and late spring, and snow in the late autumn, winter and early spring. Rainfall amounts are relatively low in the summer. The average January temperature is 29 degrees F. The average July temperature is 56 degrees F. The mean annual air temperature is 38 degrees to 45 degrees F. The frost-free period is 10 to 30 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Goodlow, Kinzel and Oneonta soils and the competing Lastance soils. Goodlow, Kinzel and Oneonta soils lack spodic horizons and are deeper than 40 inches to bedrock.

DRAINAGE AND PERMEABILITY: Well drained; slow to rapid runoff; moderately rapid permeability.

USE AND VEGETATION: The primary uses of the Thader soils are for timber production and for recreation and wildlife. Overstory vegetation

is Douglas-fir, hemlock, silver fir, noble fir, and western redcedar. The dominant understory vegetation is huckleberry, rhododendron, and beargrass.

DISTRIBUTION AND EXTENT: Cascade Mountains of northwest Oregon. The series is of moderate extent.

SERIES ESTABLISHED: Multnomah County, Oregon (Bull Run, Sandy Area), 1976.

ADDITIONAL DATA: Characterization data for one pedon (FS62-0re-045-15 (1-6)) by Oregon State University. (Unpublished)

National Cooperative Soil Survey u. s. A.

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Thader Cobbly Loam
Loamy - Skeletal, mixed Humic Crporthods
Type Location - FS 1962

Hori-	Depth	pH at	Free Iron Fe (Per-	Organic Matter (Per-	Organic Carbon (Per-	Total Nitro- gen (Per-	C/N	Phos-	Cation Exchange Capacity		tractal M <b>eq./</b> I	ole Cat 00g.)	ions	Base Satura- tion (Per-
zon	(Inches)	l:l ratio	cent)	cent)	cent)	cent)	Ratio	(ppm)	(meq./100g)	Ca	Mg	K	Na	cent)
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B22hir B3	3-17 17-28	5.1 5.4	3.78 2.36	14.3 3.6	8.3 2.1	•23 •08	36 27	2 2	45 23	0.2 0.4	0.2	0.22 0.13	0.24 0.22	2 4

Particles 2mm and smaller in size
Sand Size Fractions

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Hori- zon	Depth (Inches)	Texture Class (field)	Clay (%)	Slit (%)	Sand (%)	Very fine sand (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Very Coarse sand (%)	
A2 B22ir B3ir	o-2 3-17 17-26	fsl cobgl vcobgl	3 12 5	39 55 60	58 33 35	28 13 13	17 10 9	5 4 4	2 3 4	0 2 2	_

LOCATION PARKDALE

Established Series Rev. DFA/AON 3/75

### PARKDALE **SERIES**:

The Parkdale series consists of deep, well drained soils that formed in mud flows high in pyroclastic materials. Parkdale soils are on upland slopes and are nearly level to steep. The mean annual precipitation is about 42 inches and the mean annual air temperature is about 47 degrees F.

TAXONOMIC CLASS: Medial, mesic Umbric Vitrandepts.

TYPICAL PEDON: Parkdale loam, cultivated. (Colors are for moist soil unless otherwise noted.)

- Apl--0 to 5 inches; dark brown  $(7.5 \mbox{YR } 3/2)$  loam, brown  $(7.5 \mbox{YR } 4/3)$  dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many irregular pores; 5 percent shot, 1 to 5 mm in diameter; slightly acid (pH 6.4); clear smooth boundary. (3 to 7 inches thick)
- Ap2--5 to 10 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 5 percent shot, 1 to 5 mm in diameter; neutral (pH 6.6); abrupt wavy boundary. (0 to 6 inches thick)
- B2--10 to 18 inches; brown  $(7.5YR\ 4/4)$  silt loam, light yellowish brown  $(7.5YR\ 5/4)$  dry; weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; common very fine or fine roots; few very fine tubular pores; 5 percent shot, 1 to 5 mm in diameter; neutral (ptl 6.6); clear wavy boundary. (0 to 8 inches thick)
- C1--18 to 27 inches; brown  $(7.5 \, \text{FR} \, 4/4)$  silt loam, light yellowish brown  $(10 \, \text{FR} \, 6/4)$  dry; massive; soft, very friable, nonsticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 5 percent shot, 1 to 5 mm in diameter; neutral (pH 6.6); clear wavy boundary. (8 to 12 Inches thick)
- C2--27 to 50 inches; brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and slithtly plastic; common very fine roots; many very fine tubular pores; 10 percent firm nodules or shot, 2 to 10 mm diameter; neutral (pH 6.6); clear smooth boundary. (18 to 25 inches thick)
- C3--50 to 75 inches; yellowish brown (10YR5/4) loam, very pale brown (10YR7/4) dry; massive; soft, friable, nonsticky and slightly plastic: common very fine and fine roots; many very fine tubular pores; 10 percent firm nodules and shot, 2 to 10 mm diameter; 3 percent pebbles; neutral (pH 6.6).

TYPE LOCATION: Hood River County, Oregon; 130 feet west and 50 feet south of east quarter corner in the NE1/4 NE1/4 NE1/4 section 6, T. I S., R. 10 E.

RANGE IN CHARACTERISTICS: The soils are usually moist and are dry between depths of 8 to 24 inches for 45 days or more during the summer. The mean annual soil temperature ranges from 47 to '51 degrees F. The soils are slightly acid to neutral. The solum is 7 to 20 inches thick. The control section lacks rock fragments. The unibric epipedon is 7 to 12 inches thick.

The A horizon has hue of  $7.5 \, \text{YR}$  or  $10 \, \text{YR}$ , value of 2 or 3 moist, 4 or 5 dry, and chroma of 2 or 3 moist and dry. It has 5 to 30 percent "shot'", 1 to 5 mm in diameter.

The B2 or AC horizon has hue of 10YR or 7.5YR, value of 4 or 5 moist and 5 through 7 dry. It is loam or silt loam and has 4 to 10 percent clay. This horizon usually has weak granular or very fine subangular blocky structure but is massive and more like a C horizon in some pedons.

The C horizon has hue of 10 YR or 7.5 YR, value of 4 or 5 moist and chroma of 4 through 6 moist and dry.

COMPETING SERIES: These are the Chemawa, Cinebar, Crater Lake, Forward, Stabler, Toutle, and Yacolt series. Chemawa, Crater Lake, Forward, Stabler, and Toutle soils have ochrfc epipedons. Cinebar soils have sola thicker than 40 inches and are medium to very strongly acid. Yacolt soils have more than 15 percent rock fragments in the control section and are medium to strongly acid.

GEOGRAPHIC SETTING: Parkdale soils have nearly level to steep upland slopes at elevations of 1,000 to 2,500 feet. These soils formed in deep mud flows high in pyroclastic materials. The mean annual precipitation is 35 to 50 inches. The mean annual temperature is about 45 to 49 degrees F., the mean January temperature is about 29 to 33 degrees F., and the mean July temperature is about 61 to 65 degrees F. The frost-free (32 degrees F.) season is 100 to 120 days and for 28 degrees F. is 160 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Culbertson and Dee soils. Culbertson soils are low in pyroclastic materials. Dee soils are mottled and somewhat poorly drained.

DRAINAGE AND PERMEABILITY: Well drained; slow to medium runoff; moderate permeability.

USE AND VEGETATION: Orchard crops. Native vegetation is mainly Douglas-fir, ponderosa pine, grand pine, forbs, and shrubs.

DISTRIBUTION AND EXTENT: Uplands of north-central Oregon and south-central Washington. The series is of moderate extent.

SERIES ESTABLISHED: Hood River-White Salmon River Area, Oregon-Washington, 1972.

REMARKS: The Parkdale soils were formerly classified as Regosols.

ADDITIONAL DATA: Characterization data on 2 profiles (\$610reg-14-9 and \$610reg-14-10) reported in Riverside Soil Survey Laboratory Report for soils sampled in Hood River County, Oregon, October, 1961.

NATIONAL COOPERATIVE SOIL SURVEY U. S. A.

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SOIL SURVEY LABORATORY Riverside, California

SOIL TYPE Parkdale loam LOCATION Hood River County, Oregon

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### NATIONAL COOPERATIVE SOIL SURVEY

### Western Regional Conference Proceedings

### El Paso, Texas May **20-25**, 1984

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# WESTERN REGIONAL

## COOPERATIVE SOIL SURVEY

## **CONFERENCE**

**EL PASO, TEXAS** 

MAY 20- 25, 1985

### WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE El Paso, Texas May 20-25, 1985/ held jointly with the Southern Region

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### EXECUTIVE SUMMARY

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### CONFERENCE AGENDA

6:00 p.m. Western Hoe Down & Barbeque (Optional - See attached information on tours.)

Wednesday, May 23

South Field Trip - Desert Project Leave Hotel 7:45 a.m. Return 5:45 p.m.

West - Committee Meetings

6:30 p.m. - Juarez Fun Night & Dinner (Op-11:30 p.m. tional - See attached information on tours.)

Thursday, May 24

West Field Trip - Desert Project Leave Hotel 7:45 a.m.

Return **5:45** p.m.

South - Committee Meetings

Friday, May 25

Vi

8:00 a.m. Business Meeting (Regional)

9:00 a.m. Joint Session

Joe Nichols and Richard Kover

Committee Reports and Recom-

mendations (10 min. each)

10:00 a.m. - Break

10:20 a.m. - Committee Reports and Recommendations (Continued)

11:30 a.m. - Wrap-up and Adjournment

12:00 Noon

Southern Directors Representative D. M. Gosset

Dean. Institute of Agriculture University of Tennessee

Western Directors Representative J.C. Engibous

Head. Dept. of Agronomy & Soils Washington State University

### **Special Activities**

JUAREZ SHOPPING TOUR AND LUNCHEON Monday May 21.1964 10 am • 2:30 pm

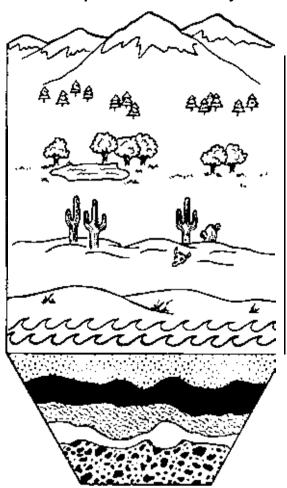
LE MESILLA TOUR AND LUNCHEON
Tuesday May 22, 1984 10am - 3:00pm

WESTERN HOE DOWN AND BARBEQUE Tuesday May 22, 1984 6pm - 10:00 pm

JUAREZ FUN NIGHT AND DINNER Wednesday May 23, 1984 6:30pm - 11:30pm

# Southern and Western Regional Technical Work Planning Conference of the

**Cooperative Soil Survey** 



El Paso, Texas

- regard to quality.
- surveys.
- logical studies.

Agency Meetings

5:00 p.m. D. Nichols, Richard Kover

Southern and Western Regional **Technical Work Planning Conference** of the

**Cooperative Soil Survey** El Paso, Texas

May 20-25, 1984

Sunday, May 20

3:00 p.m. -Registration, Holiday inn 5:00 p.m.

Monday, May 21

C.M. Thompson, Moderator

Registration 8:00 a.m. -12:00 Noon

8:45 a.m. -Introductions & Announcements

9:00 a.m. -Opening Comments Billy Griffin.

State Conservationist. SCS, Temple, Texas

E.C.A. Runge. Head. Dept of Soil & Crop Sciences, Texas **A&M** University, College Station, Texas

Ray Margo.

State Conservationist.

SCS. Albuquerque, New Mexico

LS. (Bill) Pope,

Dean of College of Agriculture, New Mexico State University

The Desert Southwest 9:50 a.m. -A Pictorial Overview

10:05 a.m. - Break

10:30 a.m. - Soil Climate & IBSNAT Projects John Kimble H. Ikawa

11:00 a.m. - Farmland Protection Policy Act Howard C. Tankersley

11:30 a.m. - Committee Report from NCSS Steering Richard Arnold

11:50 a.m. - Northeast Region Report

**12:05** p.m. Ed Ciolkosz

Lunch

L. P. **Wilding**, Moderator

1:15 p.m. - Highlights - The National Scene Dave Unger

National Resource Perspectives 2:00 p.m. -Ralph J. McCracken

**2:30** p.m. -Break

**3:00** p.m. -Panel Discussion - Education, Training and Professionalism for Soil Scientists

> Richard Arnold, Chairman, Douglas Pease, Allen L. Newman, Cliff Montague,

### Charges:

- 1. Field experience of Graduate Students and course work most useful to soil scientists.
- 2. Subjectareasconsidered beneficial for employment of soil scientists with Federal agencies.
- 3. ARCPACS, Publications, etc.

Mixer **5:30** p.m. **-**7:00 p.m.

Tuesday, May 22

8:00 a.m. - Committee Work Groups Holiday Inn and Public Library

10:00 a.m. - Break

Gary Muckel, Moderator

10:30 a.m. - Panel Discussion - Special Investigations

Co-Chairman, David Hendricks. Dave Petry, William Allardice

Charges:

1. West & South investigations Projects of joint concern. (20 min. each region)

Warren Lynn and Charlie Reynolds,

2. New Methodology (field or (laboratory)

11:15 a.m. - Panel Discussion - Quality of Soil Surveys

> Ben Hajek. Chairman, Mary Collins, Dick Cline, Herb Huddleston, Fred F. Peterson, R.B. Brown, G.W. Hurt

Charges

1. Kinds of Soil Surveys with

- 2. New statistical methods for evaluating the quality of soil
- 3. Applicability of geostatistics for survey analyses and pedo-
- 4. Computer implications

12:00 Noon -Lunch

**LeRoy Daugherty,** Moderator

1:15 p.m. - ICOMERT Juan Comerma

2:00 p.m. -Soil-Range, Team Approach Ray Miles Steve Leonard

2:30 p.m. - Break

3:00 p.m. -EPIC Model Paul Dyke. Westal W. Fuchs

3:45 p.m. -

Dave Pettry LeRoy Daugherty. Joe

### OPENING COMMENTS

By Ray T. Margo, Jr.

### OPENING COMMENTS AND WELCOME By Ray T. Margo, Jr.

As Host for the west and Co-host for the south region, I welcome you.

New Mexico of course, currently is in the west region but spent at least two years in the south region. We are a border state for the regions adhering to the procedures of the west trying to match with the south.

It is my hope that this meeting greatly expands the communication and understanding between the regions. We share many challenges, yet our approaches may be different. With more users of soil survey information the greater the importance toward meeting these user demands?

As more of our soil interpretations go into national legislation the greater the importance of consistency between states, and between regions and agencies on our soil surveys and their interpretations.

A dissimilar approach by adjoining states on the CR did not support a consistent stand. The resource areas must be correlated between states and regions for similar interpretations for consistent conservation approaches.

If legislation mentions prime farmland and capability classification, we must be sure these soil interpretations are the same within the same resource area whether that resource area be in Colorado, New Mexico or Texas.

For national computer modeling the Soil Interpretation Record SCS-Form 5 provides the basic data. Have we kept these interpretations current and coordinated?

As we finish the mapping phase of our surveys we must move into a phase of putting the surveys to work. We must not just talk among soil scientists, but go out and test our findings with our users.

When we take these surveys off the shelf we must be sure they match each other. They must not be a product of evolution of our changing system, being only somewhat similar. They must say and recommend the same things or they will lose credibility.

I hope this meeting is productive in providing the needed coordination. It is also my hope that this meeting provides greater understanding to the resource problems and concerns to those of you unfamiliar with the southwest. While you are here, note the resources and the demands.

Our top priorities in New Mexico are rangeland erosion control, cropland erosion control, water conservation, land use, rural development and flood control.

New Mexico is the fifth largest state in the U.S. with nearly 78 million acres.

Eighty one percent of the state is used for livestock grazing. Private lands make up 55 percent, federally owned lands make up most of the remaining acres. Federal agencies owning or managing lands are primarily the USFS, BLM, BIA and DOD.

Cropland amounts to a little over 2 million acres, mostly along thethWranecognize 9anaj l

### BUSINESS MEETING

### Business Meeting

### 1) Taxonomy Committee

LeRoy Daugherty, NMAES and Phil Derr

Terms expired at conference

Larry Munn - Wyoming Experiment Station and Glen Logan - SCS Idaho

Were approved for 3-year terms on the West Regional Soil Taxonomy Committee

### 2) Conference Host

Oregon was approved as conference host state.

Bob Meurisse, FS, Portland - Chairman Byron Thomas, BLM, Portland - CoChairman

Steering Committee to select time, place and tour in Oregon

### 3) Research Piority Needs Committee

It was approved: that a standing committee be appointed by the Steering Committee for the 1986 conference, whose charge shall be to review, determine and report to the 1986 conference, and subsequent conferences, research priority needs for soil survey in the Western Region. These findings shall be distributed in the name of the conference to appropriate funding and research groups such as: Coop. state Research Service, Western Directors Assn., National Science Foundation, Agricultural Research Service, National Soil Survey Laboratory, Forest & Range Experiment Station, and others as may be deemed appropriate.

### 4) Soil Temperature - Soil Moisture

It was approved: that in the absence of such a standing committee in the 1982-84 period, soil-temperature, soil-moisture and vegetation relationships be identified as this conference's current first priority research needs and that the Steering Coornittee communicate this to funding and research groups, such as: Cooperative State Research Service, Western Director's Assn., National Science Foundation, Agricultural Research Service, National Soil Survey Laboratory, Forest & Range Experiment Station and others as may be deemed appropriate.

# 5. Guam

It was approved that the University of Guam be a permanent member of the conference.

# COMMITTEE REPORTS

# WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

# Committee Assignments and Charges

Committee 1: Application of Field Procedures for Difference Orders of Soil Survey

Chairman: Richard G. Cline, USFS, Box 7669, Missoula, Mr. 59807

Glen Logan (SCS-Idaho)
Paul Bartlett (SCS-HI)
Phil Derr (SCS-Wyoming)

James Hagihara (BLM-RMF & R. Ex. St)

Dick Dierking (SCS-WTC)

Fred Peterson (Univ. Nevada-Reno)

Ed Naphan (SCS-Nevada)

Gary Muckel (SCS-New Mexico)
Tom Wiggins (BIA-Arizona)

Verlyn Saladen (BLM-New Mexico)

Jerry Harman (BLM Nevada) Gib Bowman (SCS-Colorado) Roger Parsons (SCS-WTC)

Tom Collins (USFS-Utah - Reg. 4)

Gordon Huntington (Univ. of CA, Davis)

#### **Charges:**

- (1) Evaluate results of field tests conducted in 1982 and 1983. Revise guidelines, procedures, and definitions as necessary based on these evaluations.
- (2) Examine the variety of methods available for describing procedure intensity.
- (3) Produce a revised "Kinds of Soil Surveys" documents.

# WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE COMMITTEE 1; 1984 Report Application of Field Procedures for Different Orders of Soil Survey

#### PART J 1982 COMMITTEE CHARGES

Constitute I has not accomplished as much as was mandated 2 years ago.

Concerning the committee charges (see section IV in the accompanying 1982 committee report):

#### CHARGE

- 1: LETTER SYMBOLS ON FIELD SHEETS: Not tested, apparently recone is doing it routinely and "o tests were made.
- 7: LETTER SYMBOLS NOT TO BE USED Oh' PUBLISHED MAPS: Not tested, no comment needed.
- PROPORTIONS BY PROCEEDURETN PUBLICATION: This information was derivable from the Nevada survey data (table 2). It was not derivable from the Montana survey data which was computer coded and filed in a manner which was not specific to these proceedures. This raises 3 questions: 1) Is documentation of proceedures used the most import ant issue? 2) Are these 4 proceedures (proceedure separations) the ones we want? 3) Are there other methods of reporting this information, or similar information, that would be more efficient or understandable for display purposes.
- 4: TEST PROPORTIONS BY PROCEEDURE: This information was derivable from the Nevada survey data, but not from the Montana survey. Procedure intensities could be calculated for the documented soil inspections from both surveys. The Nevada survey procedures easily met the procedure criteriaset forth by the committee for order 3 surveys. The Montana survey probably metthe order 3 transecting requirement, but was very likely more like the order 4 criteria with respect to traversing since little traversing was done. Some 38% of delineations had no soil inspections (2.58 del/insp), hence were either observed or interpreted from aerial photos. In this sense, the order 4 criteria were exceeded and the procedure might be more like order 3. Quantitative procedure intensity looked more like order 4.
- 5: PROCEEDURE AMENINGSMC

8: DEFINITION OF TERMS A PART OF KIND OF SURVEY CRITERIA: The definitions of transect and traverse have been modified slightly during the past 2 years and were discussed at the 1984 meeting. These definitions appear in appendix III (see reccommendations 2 and 3).

9 & 10: DOLUMENI

PART 3 SURVEY DATA

- 1. Data from a portion of (395,380 acres, 68 map units nnd 216 delineations) an order 3 survey of Bureau of Land Management rangeland in Nevada was available.
- 2. Data from an order 3 survey (1,524,354 acres, 95 map units and 4,077 delineations) of National Forest System land in south central Montana was available.

Both were mapped at a scale of 1:63,360 (lin/mi). These data sets were so different in character that they will be handled independently in this report except for an initial comparison (Table 1).

Table 1. Soil Survey procedural data from two order 3 soil surveys.

Survey #MU Acres Ac/MU Delineations No. of Soil Ac/Insp Insp/Del

NO. Ave Size Inspections

Nev. 68 395,380 5,814 216 1,830 3,439 115 16 Mt. **95 1,524,3354 16,046 4,077** 374 1,578 966 0.39

There are several apparent differences between these two surveys that appear in the table. These differences cannot be compared, vithout some initial assumpt ions. It must be assumed that each of the surveys was done in response to a set of reasonably well defined land management objectives. The map units were designed to respond to these objectives, and they adequately met the objectives. It must also be assumed that the field work in each area is essentially complete. This is true for the Montana survey. Comments accompanying the Nevada survey indicated there were some information gaps in the definition of map units, but they hoped to obtain more data as the survey progressed (to other parts of the survey area — chairman's assumption).

The number of acres per map unit in each survey is slightly different and suggests a different intensity of map unit definition. This estimate is obtained by adjusting the size of the Montana survey to that of the Nevada survey and comparing the acres per map unit for an equal survey area size. The calculation suggests the Montana survey is about 1.4 times more intense in delineating difference than the Nevada survey. The size of delineations agree with the trend, but the difference is more striking, suggesting the Montana survey is some 4.9 times more intense. The procedure intensities suggest just the opposite, however. The Nevada survey was some 8.4 times more intense based on acres per soil inspection and 41 times more intense on the basis of inspections per delineation. This inspection density comparison may not be quite valid. The number of soil inspections in the Nevada survey is an estimate based on a few transect sheets provided with the data. These sheets indicated that the number of soil inspections per transect and per traverse were not different and averaged about 19. This was assumed for the comparison. This comparison, if it reflects differences in basic character of the two surveys (as a trend, not necessarily in numerical terms), suggests that the Montana survey was more intensely delinested, but less intensely documented in terms of soil inspection. This is probably related to differences in survey objectives which control map unit design. If this conclusion is valid, it suggests some interesting dilemmas when attempting to set specifically defined survey order criteria. This is undoubtedly the source of msny of the arguments surrounding this issue.

Another comparison from the data supports the procedure intensity comparison. The data on soil inspections and map unit observation for the Nevada survey indicate no map units were without at least some soil inspections. The data on procedure application is shown in Table 2.

Table 7. Procedure application in the Ne	vada soil survey.
Procedure	X of Delineations

Transect	18
Traverse	50
Observation	23
Aerial Photo Interpretation	9

1/ The percentages indicate only the most intensive procedure, i.e., traversing may have been conducted on delineations containing transects, but will not be shown in the percentages.

There were no data on boundary identification. and it is assumed there is no documentation available.

The same data is not available for the Montana survey. A comparison can be made, however. The soil inspections recorded for the Montana survey came from transect records in most cases. The transects contained 5 to 7 inspections each and, unlike the Nevada survey, the transects did cross delineation boundaries. There is no record, however, of a boundary identification procedure, so none is assumed. Unlike the Nevada survey, there are map units in which there are no recorded soil identifications. This occurred in 10 of the 95 map units. In these cases, soil definition of these units was extrapolated from soil-topographic. soil-lithologic, and soil-vegetative relationships observed in other map units with similar mapping differentis. In each case, these map units had distinctive photographic signatures and correlations with soil occurrence were easily derived. These relationships are contained in the soil classification section of the survey report. The summary of soil inspections by map unit is in an appendix to that report and is appended to this one (appendix II). Reference to that table will indicate a wide variance in procedure intensity within the survey. This is not unusual. Some variance in procedure intensity appeared in the Nevada survey data. It was not as large as that of the Montana survey. This probably reflects differences in design objectives, map unit by map unit. Each map unit in any survey is unique to some extent. This is a result of survey objectives, the peculiar landscape characteristics of the unit which control the mapping differentia and the design considerations encountered as the map unit developed during the course of the survey.

A related comparison between these two surveys is the indication of soil prediction reliability obtained from the field data. The occurrence of components of map units accompanied the transect data for the Nevada survey. This data is limited to single transects. hence is not a complete set for the

map unit. Data from the Montana survey is complete. It was taken from the survey data records and compared to the map unit descriptions. This comparison appears in Table 3.

Table 3. Mapunit component estimated and observed occurrence for two mapunits in two different order 3 soil surveys.

Map Unit Component Occurrence (%)						No.
1	•	Estimate	Observed	<u>Confidence</u>	Limit Lower	ed0
			3/			
		Nevadi	a Survey			
3225	1	75	47	65	30	19
(association)	2	13	21	40	10	19
	3	10	16	34	6	19
	inc 1.		16	34	6	19
3135	1	75	40	58	25	21
(association)	2	15	29	46	16	21
(association)	incl.	10	31	49	17	21
		Mank				
		uone	a <u>na Survey</u>			
12-1C	12/	80	56	69	43	39
(consociation)	$\frac{3}{2}$ 2/	15	21	33	12	39
	Rock	5				
	incl.		23	36	14	39
862A	12/ 22/ 32/	40	30	48	17	23
(association)	22/	40	48	64	32	23
(GODOCAREAOR)	$\tilde{3}^{2}$	15	9	23	3	23
	Rock	5	U	~0	U	~ <del></del>
e e e al la lacianta de lacianta de lacianta de lacianta de lacianta de lacianta de lacianta de lacianta de la	incl		13	29	5	23

<sup>1/</sup> At 90% confidence level.

The data in Table 3 suggest a not unusual misestimation of component occurrence. This has been documented in the professional literature on numerous occasions and needs no discussion here. It is interesting to note that the problems of estimation appear similar in both surveys. One suspects the errors of estimation do little if any damage to map unit utility. Most mappers understand management objectives and design map units to both combine and separate landscape features important to those objectives.

Roth of these surveys claim to be order 3 surveys and were mapped at the same scale. The Montana survey seemed more intense on the basis of delineation intensity. The Nevada survey seemed more intense on the basis of procedure intensity. Errors of estimation of soil occurrence seem similar when compared to field data. This similarity probably holds where procedure intensity is comparable. Where ground truth is lacking, soil prediction is probably less reliable. This kind of reliability may or may not correspond to map unit interpretive reliability. depending on map unit design objectives. If the

<sup>2/</sup> Estimates of occurrence include other taxa considered similar in the map unit description. Descriptions appended to report (appendix I).

<sup>3/</sup> Estimates oi occurrence are field occular estimates.

Nevada survey procedure intensities are similar throughout the survey it is probably the more intensely ground **truthed** of the two surveys. By Keith Valentine's procedure intensity guide, the Nevada survey is easily order 3; on the detailed end. but not an order 2. The Montana survey looks like a" order 4; on the detailed end. but not particularly close to order 3.

#### PART 4 COMMENTARY

Several letters have bee" received concerning survey concepts and orders of inventory. A letter from Phil Derr seemed a particularly interesting and thoughtful discussion so I will attach it as appendix IV. Phil commented on most of the points made by other respondents.

One respondent suggested a time available criteria may be important in evaluating soil surveys as this controls the degree of detail possible in thr finished product. Other comments have been received suggesting both that we tighten the order of survey definitions and that we make them more flexible. We ate going to have to decide which, because we cannot do both.

The current status and history of our order of soil survey concepts suggest we have a single category classification system without a very well defined objective. The current set of criteria seems to be a mixture of definitions and criteria partly oriented toward setting quantitative intensity limits for people doing soil surveys and partly oriented toward defining intensity levels for people who manage soil survey programs or use soil surveys. Another possibility is that we have been trying to set criteria because of the feeling that criteria need to be set. By itself, the last objective is not a valid one. The second objective seems the most useful end has the potential of providing information helpful in dealing with the first. How much definition do we need at a Regional or National scale? What does a soil survey program manager need to know about a soil survey to make sound management decisions? Five critical questions came to mind.

- 1. Why is a soil survey needed? No one should automatically assume one is needed. That is a "motherhood" asumption which does not help solve the program manager's problem. What are the survey's objectives?
- 2. What kind of information is needed to satisfy the answer to number 1?
- 3. How much expenditure is required to obtain the information?
- 4. Can we afford the expenditure?
- 5. If the answer to 4 is no, what adjustments ran be made to partially meet the requirements of 2 with the available resources?

Table 4 is a first tentative attempt to organize these questions in a tabular form. It approaches the problem with an emphasis on the decision variables controlling the kind of survey (interpretations to be made) to be done and the amount of effort required to do it. It avoids specifying scale of mapping. Scale is a cartographic problem which is only partly controlled by survey objectives. Many different users use the same cartographic product at several different scales. The appropriateness of this action is beyond the control of the survey producer in many cases. Cautionary statements can be made, but just as easily ignored. Maybe the best alternative for the survey producer is to base risk assessment on something irrevocably tied to the scale of the land.

Table 4 also avoids specifying the kinds of map units to use. The kinds of map units in any survey are not dictated by a policy statement. They are dictated by survey objectives and landscape complexity as they influence map unit design. The mapper needs the flexibility to tailor his own map units. No correlator of administrator is even remotely qualified to specify kind of map units to use prior to a survey's execution. This is what our current table of kinds of survey implies.

The definition of kind of survey depends on the statement of survey object ives. These objectives need to be stated in terms specific enough to define the kind and specificity of interpretations "ceded. The test of survey quality requires an assessment of whether or not survey objectives are met. A very general reconnaissance survey is a good quality survey if it can be shown to do this. A very detailed survey is a poor survey if it does not accomplish this task. Kind and quality of survey are not the same thing. We seem to have these two ideas intermixed in our current definitions.

Table 4. Representative soil survey procedural objectives for various land

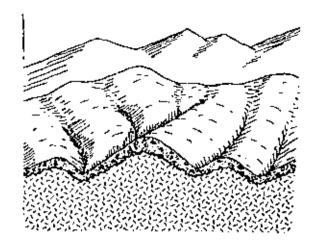
Land Use	Interpretat ions Required (examples only)	Representative Rate of Progress (acx10 <sup>-7</sup> man year)	Representative Procedure Intensity (ac/soil insp)
Irrigated Agriculture	crop yield salinity drainage	16	4
Dryland Agriculture	crop yield salinity <b>drainage</b>	50	10
Range (extensive)	forage yie ld carrying capacity water availability access (stock)	100	80
Timber (intensive)	fiber yield (vol) silvicultural logging systems	100	80
Timber (extensive)	fiber yield (vol) silvicultural logging systems	300	500
Watershed	erosion sediment yield substratum water ref	300 tention	500
Wildlife Habitat	quality component distributi	500 on	700
Vi sua 1 Management	visual quality variety sensitivity	1,000	<sup>1</sup> <sub>2</sub> 2,000
Wilderness	<pre>sensitivity to use visualqual ity carrying capacity</pre>	1,000	½2,000
Wildfire	fire frequency resource sensitivity rehabilitation	1,000	<sup>1</sup> <sub>2</sub> 2,000

Ranges are purposely not used. A central concept system provides flexibility in boundary adjustment.

# APPENDIX I

# MAP UNIT DESCRIPTIONS

12-1C Typic Cryochrepts, gently rolling ridges
86-2A Typic Cryoborslfs-Argic Cryoborolls Association. bedded substratum



GALLATIN FOREST AREA SOIL SURVEY

Draft

MAP UNIT DESCRIPTION

M.U. 12-10

#### MAP UNIT SUMMARY

<u>M.D. SETTING</u> The immdform consists of rounded ridges and adjacent gentle sideslopes (center of block diagram). Delineations are in the northern Caliatin Range, northern Madison Range, west and south of Madgen Lake, northern Absaroka-Beartooth Range, and southwestern part of the Crazy Mountains.

M.O. COMPONENTS Soils are moderately coarse to medium textured. They have formed in material meathered from hard crystalline rock. Native vegetation is dense lower subalpine forest.

ADJOINING M.U. Adjacent units are steep irregular racky slopes or support upper subalping forest vegetation.

#### TOPOGRAPHY

ZLOPE (X)	ASPECT	ELEVATION (FT.)	ROCK OUTCHUP (%)
0-20	Variable	6.500-7,800	ş

Smooth rounded, nearly level to gently rolling, convex ridgetops and lower slopes are typical landforms. Bedrock exposures occur on high points or along delineation margins. These rounded ridgetops are dissected by poorly defined intermittent streams. The drainage system has a dendritic pattern with low to moderate channel gradients. They have high subsurface water storage capacity and surface runoff occurs rarely.

#### VEGETATION

MABITAT TYPE (HI) <u>OCCURRENCE</u> The unit consists of subalpine fir/grouse whortleberry (ABLA/YASC), subalpine fir/blue hockleberry (ABLA/YASC), and subalpine fir/blue grass (ABLA/CARU) - 85 percent. Included RIs with dissimilar management implications are subalpine fir/bluejoint (ABLA/CACA) and subalpine fir-whitebark pine/grouse whortleberry (ABLA-P(AL/YASC) - 10 percent

HABITAT TYPE DISTRIBUTION ABLA/VASC and ABLA/YAGE occur throughout the unit. ABLA/CARU is only on southern exposures. Subalpine fir/heartless and low timber productivity are associated with these RTs.

included are up to 10 percent dissimilar MTs. ABLA/CACA occurs on wet sites adjoining stream channels and ABLA-PIA:/VASC is at higher elevations. ABLA/CACA is a more productive timber site and ABLA-PIA:/VASC is less productive.

<u>Existing VECTIATION</u> consists of dense lodgepole pine forest. The forest understory is composed of a chick mat of shrubs, dominated by grouse whortleberry and blue huckleberry. On southern exposures the understory is dominated by progress.

#### GEOLOGY

OCCURRENCE The unit is underlain by hard crystalline bedrack - 85 percent; sandstone and rhyolite - 15 percent.

The bedrock consists of coarse grained rocks, such as granite or gneiss of Precambrian age. This bedrock weathers slowly and outcrops form high points in the local landscape. Sandstone and rhyolite are included as similar bedrock. Deposits of glacial coll similar to material weathered from the underlying rock occur in depressions or valleys.

#### **SOITS**

GIALRA: MATURE OF SOILS. The soils are somewhat excessively drained and slightly to moderately acid with moderately coarse and medium textures. The subsoil contains 35-50 percent angular rock fragments.

OCCUPACACE AND DISTRIBUTION. The major soul has light colored surface layers and moderately coarse textured subsoils. It occupies 80 percent of the unit, included as similar are soils with fener subsoil rock fragments, darker colored surface layers or moderately acid subsoils. Soils with moderately acid subsoils are at higher elevations. The other similar soils are not associated with landscape Features.

Small areas of dissimilar soils are incl<u>uded. Soils with Finer testured subsoils are in areas underlain by micaceous</u>

CENERAL DESCRIPTION. The soil surface is covered by a layer of partially decomposed forest litter less than one inches this. The subsoil is very pale brown, very copally come about 3 inches thick. The subsoil is very pale brown, very copally contained the pale that the substitute is not about 20 inches thick. The substitute is not about 20 inches thick.



tal, wixed.

The included dissimilar finer textured soils are Mollic Gryoboralfs, fine loamy, mixed.

#### MANAGEMENT IMPLICATIONS

limble. The unit is well suited to timber management. Potential annual production is D3-50 cu. ft./acre. There are no Timitations to equipment operation. Regeneration is moderately limited because of moisture stress. This stress is closed by the soils low available water holding capacity and competition from pine grass on southern exposures. Besign of cutting units to prolong snow melt and creating shade with slash can help overcome this limitation. Rock fragments on the surface or in the soil limit hand planting.

RCADS. The unit is well suited to road construction. Roads perform well with ordinary construction and maintenance practices.

RANCE The unit is poorly suited to range management. The forest understory produces little useable forage. It is  $\overline{poorly}$  swited for use as transitory range following timber harvest.

<u>will DE IFF-FISHERIES</u> This unit is potentially fair habitat within summer and fall elk range. It provides good security tover after timber stands have reached the sapling-pole stage of development. It does not contain or border streams large enough to support fish.

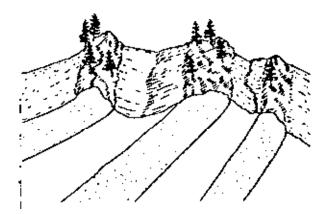
#### INTERPRETATIONS

Landslide Hazards	very low
Soil Eredibility	moderate
Sediment Belivery Efficiency	very los
Timber Productivity	low
forest Regeneration Limitations	moderate
Forest Understory Forage Production	low
Kon-forest Herbage Productivity	

See Use and Management Section for more detail.

# CLINATEC FEATURES

Bean Annual Precipitation (inches)	20-35
Precipitation Distribution	60% sngw, 40% rain
Average Winter Snow Depth (Inches)	26-60
Spring Runoff	April-May
tength of Frost Free Season (days)	50-90
Potential Evapotranspiration	moderate
Hydrologic Sail Groups	A-8



\$1.098 (\$)

GALLATIN FOREST AREA SOIL SURVEY

Oraft

MAP UNIT DESCRIPTION

M.U. 86-2A

#### MAP UNIT SUMMARY

H.U. SETTING The landtorm consists of gently sloping to moderately steep, structurally controlled slopes (block Glagram). Belineations are mainly in the Gallatin Range, southern Madison Range, Medgen Lake area, and Absorph Beartooth Range.

M.U. COMPONENTS. This unit contains an association of soils. Soils are moderately fine textured. They have formed in material weathered from thickly bedded sandstone and shale. Mative vegetation is dense lower subalpine forest and mountain meadows.

TORRESON

ADJOINING M.U. Adjacent whits have steep structurally controlled slopes, mountain grassland or dense upper subalpane forest

to Edward Ite	
ELEVATION (FT.)	ROCK OUTCROP (

45 Yariable 6,800-8,990

ASPECI

The unit consists of ridges with gently sloping to moderately steep concave slopes and occassional small valleys or swales. The shape of these landforms is strongly controlled by the underlying interbedded bedrock. Ridges are generally underlain by sandstone which is often exposed on ridgetops. Small valleys and swales are underlain by "soft" shale, sittstone, or mudstone. Landscapes can be complex depending upon the bedding characteristics of the underlying rock. Slope of the land surface seldom conforms to underlying bedrock dip. These slopes are dissected by poorly defined, intermittent streams. The drainage system has a dendritic or rectangular pattern with lox channel gradients. These landshide hatteds in 20-40 percent of the unit. They have high subsurface water storage capacity and surface runoff occurs rarely.

#### VEGETATION

INSITAL TYPE (HI) OCCUMENCE. The unit consists of subalpine fir/plue buckleberry (ASLA/VACL) and subalpine fir/twin Tlover (ASLA/VACL) - 45 percent; and loand fescue/bearded wheatgrass (FEID/AGCA) - 30 percent. Included His with dissimilar management implecations are subalpine fir-whitebark pine/grouse whortleberry (ASLA-PIAL/VASC) - 10 percent; and Douglas-fir His with shrutby understory unions - 10 percent.

MABILAL TYPE OLSTRIBUTION ASCA/VACK and ABLA/CIBO are in forested areas. Similar included RTs are subalpine fir/neartleaf arrica (ABLA/ARCO), subalpine fir/grouse whom Lieberry (ABLA/YASC) and Engelmann spruce (PEEN) MTs. Gool, moist climates and moderate timber productivity are associated with these MTs. FEID/AGCA is in mountain meadows. Similar included MTs are big sagebrush/Idaho fescue (ARTR/FEID) and Idaho fescue/ bluebunch wheatgrass (FEID/AGSP). Coul moist climates and migh range productivity are associated with these MTs in this unit.

Included are up to 20 percent dissimilar HTs. ABLA-PIAL/YASC is at upper elevations on less productive timber sites. Doubgas-for HTs are at token elevations on sites where forest regeneration is more difficult.

<u>Existing RECEATION</u> consists of dense lodgepole pine and subalpine fir forest with large mountain meadows. The forest <u>understory is composed</u> of a thick mat of shrubs dominated by blue huckleberry, twin flower, and grouse whortleberry, neartieal armica, virgins bower and pinegrass also occur. The mountain meadows consist primarily of bearded wheatgrass, countain brone, timber untgrass, stocky geranium and abundant forbs. Occasionally, big sagebrush forms a dense overstory.

#### GE Ot OGY

OCCURRENCE The unit is undertain by interbedded shale, siltstone, and sandstone - 100 percent.

The bedrock consists of thick beds of light colored sandstone shale, mudstone, or sillstone. Slope of the land surface seldom conforms underlying bedrock dip. The bedrock is upper Cretaceous to Triassic in age. The most common gradegic formations are lelegraph Creek, Cody, Rowry-Thermopolis, Kootenai, Morrison, and formations of the fills group. The Albino furmation occurs locally in the Madison and southern Gallatin Range.

Included behrock with dissimilar properties is highl colored quartiatic sandstone of the Quandrant formation. Weathering products from this bedrock are more erodible.

#### SOLLS

GINERAL NATURE OF SOILS Soils are moderately well drained and moderately fine textured with subsoil clay accumulation. Subsoils contain 10-20 percent rock fragments.

OCCURRENCE AND DESTRIBUTION The unit contains an association of soils. Soil properties vary with vegetation. Soils formed under forest have light colored surface layers. Included are similar soils with more subsoil rock fragments or darker colored surface layers. These soils occupy 40 percent of the unit. Soils formed in mountain or meadows have dark colored surface layers. Similar included soils have core subsoil rock fragments. These soils occupy 40 percent of the unit.

Included are up to 15 percent dissimilar coarser textured soils with greater than 35 percent subsoi) rock fragments. These soils are near sandstone outcrops on less productive timber sites.

GIATRAL DESCRIPTION The forested soils have very pale brown, loam surface layers about 9 inches thick. Subsoils are relievish brown, Clay loam or gravelly clay loam about 23 inches thick. The substratum, a variable pecause of variable clay loam, overlies bedrock at depths of 3 to greater than 5 feet. Soil colors are more variable because of variable parent material colors. See soil description 3 for more getail.

The meadow soils have dork grayish brown, silt loam surface layers about 8 inches thick. Subsoils have variably colored clay loams about 13 inches thick. The substratum, a variably colored gravelly or cobbly clay loam overlies begrock at depths of 3 to greater than 5 feet. Soil colors are variable because of variable parent material colors. See soil description 16 for more detail.

CLASSIFICATION REMARKS. The forested soils with light colored surface layers are Typic Cryoboralfs, fine loamy, mixed. Similar soils are Typic Cryoboralfs, loamy skeletal, mixed and Hollic Cryoboralfs, fine loamy mixed. The meadow soils are Argic Cryoborolls, fine loamy mixed. Similar soils are Argic Cryoborolls, loamy skeletal, mixed.

the included dissimilar solls are Typic Cryochrepts, loamy skeletal, mixed.

#### PARAGEMENT SEPLECATIONS

TIPER The unit is well suited to timber management. The potential annual production in forested areas is 53 to 69 cu. It. face. The unit is generally well suited to tractor operation. The forest helps stabilize unstable slopes. Timber harvest can increase the risk of landslides. Under certain maisture conditions, equipment operation can compact or rut the soil. This timitation can be overcomed by using equipment when soil is dry, covered with snow, or by using cable yarding systems. Understory vegetation competes slightly with tree seedlings in some areas. Reducing competing vegetation overcomes this limitation.

<u>RDADS</u> The unit is moderately suited to road construction. Unstable slopes occur commonly. Slope stability should be evaluated before planning or locating roads. Locating and designing roads to avoid wet soils and cutbanks over 5 feet high helps avoid cutbank and fill sloughing. Unsurfaced roads become rutted when wet and dusty when dry. Surfacing or scatonal closures help overcome these limitations.

RANGE The unit is well suited to range management. The potential native meadow plant community produces about 2,225 pounds per acre of sir dry herbage in normal years. The meadow areas occupy 30 percent of the unit but provide over 30 second of the angitable forage. Through may have invaded these meadows. This may affect scason of use and utilization. The forest indicates flowed as little forage. Forage production increases after timber harvest and these areas are orderately suited for use as transitory range.

Eito IFE -FISHERIES The unit is potentially good summer and fall elk and mouse habitat. Good summer grizzly bear habitating does not border streams containing habitat.

#### ZHOLTAT 39\$9 3F#1

Laudslide Marards	moderate
Soil Eradibality	low
Seatment Delivery Efficiency	moderate
Inmoer Productivity	Moderate
Forest Regeneration Limitations	Slight
Forest Understory Forage Productivity	lo-
Grassland and Smrubland Productivity	high

See Use and Hanagement Section for more detail.

#### CLEMATIC FLATURES

Mean Annual Precipitation (Inches)	25-40
Precipitation Distribution	60% snow; 40% ratio
Average Winter Snow Depth (inches)	26-60
Spring Runoff	April-May
Longto of Frost Free Season (days)	50 - 90
Potential Evapotranspiration	moderate
Mydrologic Soil Groups	B 2.164

38

DATA FROM

MONTANA SOIL SURVEY

PROCEDURE INTENSITY

APPENDIX II

# PROCEEDURE INTENSITIES

This soil survey is a reconnaissance soil survey. It covers a variety of kinds of land with varying land use intensities. This results in a variable requirement for intensity of map unit inspection. Table A37 contains several sets of information designed to 'provide the survey user with an understanding of how intensely each map unit was investigated.

This information does not directly assess map unit interpretive reliability. Interpretive reliability of map units depends on the **relationships** among a map unit's design objective, the interpretation desired and the reliability of occurrence of map unit properties upon which the interpretation is based. All interpretations in this survey do not depend solely on soil properties nor on soil taxonomic definition.

The information in Table A37 accounts only for documented soil inspections. Many inspections were made which were not written down. The undocumented inspections have had a strong influence on map unit definition and naming. The procedure intensity information in Table A37 should provide a good perspective, in quantitative terms, of the relative intensity of field investigation for each map unit.

Table A37. Map unit extent and procedure **intensities** 1/ for documented field inspections (Ins) of soils.

M.U.	Extent	Delineation(Del)		No.	Proce	dure
		No •	Av .	Ins	inten	ties
	Acres		si ze	l	Ac/Ins	Del/Ins
			Acres	<u> </u>		
12-1A	17,452	34	513	26	671	1.31
12-1C	7,558	14	540	39	194	0.36
12-2A	8,276	21	394	11	752	1.91
12-2B	6,947	28	248	1	6,947	28.00
13-1A	12,481	35	357	2	6,240	17.50
13-2A	4,900	18	272	8	612	2.25
22-1A	23,479	71	331	4	5,870	17.75
22-1B	13,490	26	519	8	1.686	3.25
22-1C	66,179	81	817	1	66,179	81.00

Table A37 (cont.)

H.U.	Extent	Del	eation(Del)	No.	Proce	dura
n.u.	extent	-		1	intens	
	Annon	No	AV.	Ins	Ac/Ins	
	Acres		size Acres		AC/Ins	Del/Ins
22-2A	5,996	18	333	<u> </u>	5,996	18.00
22-3A	20,240	54	375	9	2,249	6.00
22-3C	6,968	Y	774	0	2,210	0.00
25-1A	12,853	65	198	5	2,571	13.00
25-3A	22,526	94	240	20	1,126	4.7
34-1A	10,584	51	208	8	1,323	6.38
34-1B	8,427	26	324	17	496	1.53
34-1C	39,280	72	546	21	1,870	3.43
34-ID	5,616	18	312	0	1,070	0.10
34-2C	8,928	34	263	7	1,275	4.86
34-2D	17,534	41	428	15	I, 168	2.73
34-3A	9,514	26	366	6	1,586	4.33
34-3B	18,141	41	442	51	356	0.80
34-48	4,356	14	311	12	363	1.17
34-4C	10,236	41	250	14	731	2.93
35-1A	15,089	60	251	3	5,030	20.00
35-1B	7,034	32	220	32	220	1.00
35-1C	21,193	68	312	17	1,247	4.00
35-2C	10,568	41	258	7	1,510	5.86
35-3A	°,796	38	258	1	9,796	38.00
35-3B	13,012	44	296	32	407	1.38
35-4C	3,413	27	244	0	107	1.00
46-1B	9,707	27	360	22	441	1.23
46-2A	13,676	46	297	13	1,052	3.54
46-3A	30,442	9	3,382	8	3,805	1.13
53-1A	8,123	43	189	17	478	2.53
53-1D	9,225	35	264	31	298	1.13
53-3A	7,787	35	222	2	3,894	17.50
53-3B	4,893	19	258	11	445	1.73
5 3 - x	6,806	29	235	10	681	2.90
54-1A	23,511	90	261	44	534	2.05
54-1B	35,686	67	533	17	2,099	3.94
54-1C	18,260	63	290	44	415	1.43
54-1E	24,082	52	463	27	892	1.93
54-1G	52,758	101	522	25	2,110	4.04
54-2B	9,650	28	345	23	420	1.22
54-2C	15,968	39	409	21	760	1.86
54-2D	14,409	31	465	0		1.00
54-2E	3,036	6	506	0		
54-3A	16,210	5 <u>9</u>	275	3	5,403	19.67
54-3C	23,124	58	399	14	1,652	4.14
54 <b>~</b> 30	28,439	78	365	19	1,497	4.11
54-3E	2,448	8	306	0	=, = 0 ,	
54-3F	28.667	58	494	23	1,246	2.52
54~5A	9,942	27	368	16	621	1.69
54-5C	23,121,	23	1,005	13	1,778	1.77
61-2A	5,370	16	336	11	488	1.45
64-2A	16,344	92	178	10	1,634	9.20
64-2C	16,165	85	190	20	808	4.25
66-1A	13,138	71	185	14	938	507.
71-1A	31,386	71	442	78	402	0.91
					ı	

M.U.	Extent	)eli	neation(Del)	No.	Proce	dure
1,1,0,	an conc	No .	Av •	Ins	inten	ties
	Acres		size		Ac/Ins	Del/Ins
			Acres		-	
71-1B	7,278	30	243	26	280	1.15)
71-1C	14,771	23	642	30	492	0.77
71-1D	12,293	48	250	0		
71-1E	6,634	30	221	11	603	2.73
71-2A	13,180	36	366	34	388	1.06
71-28	14,541	46	316	2	7,270	23.00
71-2C	10,546	16	659	28	377	0.57
71-2D	5,415	21	260	14	389	1.50
82-2B	10,787	25	431	9	1,198	2.78
82-2C	10,498	16	656	10	1,050	1.60
84-1A	10,289	21	490	0		
84-1B	7,242	11	658	0		
84-20	16,772	26	645	26	645	1.00
85-2A	17,813	36	495	33	540	1.09
85-2B	11,152	23	485	37	301	0.62
85-3A	39,772	55	723	15	2,651	3.67
85-3B	24,920	54	461	10	2,492	5.40
86-2A	13,548	48	282	23	589	2.09
86-2C	17,258	86	201	36	479	2.311
86-2D	18,726	55	340	43	435	1.28
86-2E	11,368	35	325	10	1,137	3.50
86-3B	23,848	51	468	16	1,491	3.19
86-3C	18,451	82	225	46	401	1.78
87-1A	51,437	31	1,659	28	1,837	1.11
87-1B	5,342	25	214	3	1,781	8.33
87-1D	19,501	57	342	24	813	2.38
87-2A	16,319	46	355	16	1,020	2.88
87-2B	11,488	45	255	0		
87-2C	9,791	57	172	39	251	1.46
87-2D	14,299	46	309	25	569	1.84
87-2E	13,184	39	338	4	3,296	9.75
88-1A	17,330	5	3,466	8	2.166	0.63
88-2A	12,059	9	1,340	16	754	0.56
91-2B	26,217	31	846	13	2,017	2.38
93-1A	45,880	217	I 211	4	11,470	54.25

	Acres	Delin	eation	No.	Proc	edure
		No.	Av.	Ins	intens	sities
			size		Ac/Ins	Del/Ins
TOTAL	1,524,354	4,077	3 7 4	1,574	966	2.58

<sup>1/</sup>Proceedure intensity is a measure of the intensity of documented field varification (ground truth) obtained.

# APPENDIX III FIELD PROCEDURE DEFINITIONS

Kind of Soil Survey Table Soil Survey Manual Cb. 2

1982 COMMITTEE REPORT

# FIELD PROCEDURES USED TO IDENTITY DELINEATIONS

A. Transect (1) The field procedure of knowing delineations of landscape units along selected lines to determine the poticity of polypositions with respect to landscaping geologic formations or other observable features. Thus sasible of simply determinable features are related to some and such occurrence can be produced locally from these features.

Transects require explicit documentation including (1) a symbol locating the transection and keying the documentation to a held sheeted gift 300). (It a plantmetter sketch of the location of the transect within the defineation showing variations from a straight link, etc., (c) a trans-section displaced agreement agreement agreement agreement agreement of the landscape factor related to each soil boundary, and (f) the percentage scale imponent composition based on the cross transect tempt. This document is all dairs the composition of soil map units factorially soil associations that explicitly shows the mapping closs by which adonument of the landscape factor related. Air photo interpretation is used during transecting.

(2) lacinitising pedons at regularly spaced intervals (i.e., gridding)

Also 43% a procedure of crossing defineations on selected or random lines, and identifying pedans at predetermined points for subsequent forms for informal statistical explication to establish the composition and variability of a defineation or mapping one.

By Transers Authorition of the predicted boundaries or composition of a delineation by entering it or crossing it and identifying pedians at selected or rational positions.

A craverse requires that the significant his items of each solicomponent and delinearism be examined physically by shower or augability of Chile? It and it success, the focation of the examination should be shown by a symbol within the delinearism drawn on the held sheet, and keyed to field indicate are made. If all component soils of a delineation are not examined or the examination site is not located by a symbol the mapping appropriate that the considered an indicate that if Air phonometrip relation is used during traversing.

C. Observation A word checking of landscape features, expéred geological formations, or chance exposures of pedons from within in without a duringuism to prince the boundaines and composition from previously determined relations, are photos may be used as guides. This is a few intensive operation than transfering.

Identification of component softs by observation uses an photo interpretation, but requires an one-ground cless close ground. But out subset structs shown and change exposures of soft bottoms can be seen clearly, i.e., placer than a few bondred sards. Air photo interpretation, on solves from a result are used observations. If hamples of observations seeing fragments of a periodical product bank exposure of an arget a bondred from a pickup window. A two foot high scarp that is known to separate soils, but is not suitable on streep air photos. Cophiles of linessors on a fillular are a clied for a particular soil. Indicator plants or changes in shrob height of density that is related to soil change. The sensation of softer or filmer soil when walking across an area, and noting it is related to soil color and apparent texture. Sait efforcisenses.

j) Air Planta Interpretation: Proof og bnunderies and estimating composition of delineations based on air photo features that have been to fared to sails and bandscape teatures. As the term is used here, air photo interpretation includes applicable remote sensory.

Amphoto interpretation is a strictly intellectual, second hand conclusion based on previous correlation of landscape features and photopatiers to solve. In compatibility and "observation" is a concrete, novel experience where many more landscape features are apparent and their significance can be fested, than is possible with his photos, particularly at scales appropriate for Order 3 and 4 mapping

ATTACHMENT 3

#### COMMITTEE 1

APPLICATION OF FIELD PROCEDURES FOR DIFFERENT ORDERS OF SOIL SURVEY

- I. Charge 1 Evaluate testing of field procedures described in 1980 Conference Committee 1 report.

  - Test procedures for field sheet display of mapping intensity.
     Test guidelines for delineation-identification procedure intensity.

#### DISCUSSION

- Committee 1 of 1980 Work-Planning Conference presented amplified definitions for field procedures. These definitions included those for transects, traverses, observations, and sir photo interpreta-A recommendation proposed for testing included a field sheet display which would reflect mapping intensity. This display would be accomplished by writing a symbol in each delineation that reflects the major field procedure used for identifying the soil(s) of the delineation, thus documenting quality of map units. following attached to the map unit symbol indicates:
  - A soil identification by transect
  - B soil identification by traverse
  - C soil identification by observation
  - D soil identification by air photo interpretation.
- Committee 1, 1980, also recommended "Guidelines for Delineation -Identification Procedure Intensity." These guidelines consisted of the proportions of each delineation to be identified by the various procedures for each map unit of Order 2, 3 and 4 soil surveys.

# 1980 WESTERN CONFERENCE GUIDELINES FOR DELINEATION -IDENTIFICATION PROCEDURE INTENSITY

·		Soil Survey Order	•
Mapping Procedure	Order 2	Order 3	Order 4
	<b>%</b> of delin	eations of <b>each</b> m	ap unit
(A) Transecting	15-30	10-15	1-5
(B) Traversing	50-65	25-50	10-15
(C) Observation	5-15	25-50	40-60
(D) Air Photo Interpretation	<b>&lt;</b> 5	10-20	20-30

II. Charge 2 - Revise proposed guidelines, procedures, and definitions as necessary and draft a revised "Kinds of Soil Surveys" document.

<u>DISCUSSION</u> - The work of the committee in relation to this charge was primarily devoted to a review of the prior work of ad hoc committee 7, Kinds of Soil Survey, which led to the present document. Recommendations for changes and additions are made in this report.

# Work of the 1982 Committee 1, entitled "Application of Field Procedures for Different Orders of Soil Survey."

- A. Most of the work of the committee was done by correspondence which reported on testing of the proposed procedures recommended by the 1980 committee 1 and suggested revisions of the criteria defining "Kinds of Soil Surveys." These reactions to testing were reported:
  - 1. Field trials of displaying the symbols for field procedures on the field sheets indicated that it is no problem for field workers to do this.
  - 2. Some personnel found that writing detailed pedon descriptions for each point sampled on a transect demanded an unreasonable amount of time. The requirement for detailed pedon descriptions in transect sampling needs to be changed to a mere requirement for soil identifications of components.
  - 3. Responses to testing criteria for procedures for delineation identification proposed by the 1980 committee indicated that they demanded too many transects. It was generally indicated that the requirements imposed for transecting are too time consuming.
  - 4. A brief historical review of the development of the "Kinds of Soil Surveys" concepts was prepared and is appended.
- B. In responding to the tests and reports by field personnel, this committee is proposing the following recommendations for testing in the next two-year period.

#### IV. Recommendations

- 1. That the letter symbols A, B, C, or D, for the field procedure used to identify composition of a delineation, should be written in on the field sheets for each delineation. It should be written belownot as part of--the map unit symbol in the delineation.
- 2. That the letter symbols for field procedures should not be used on the published map.
- 3. That the proportions, by percentage of total acreage, of the field procedures used to identify the delineation composition of each map unit should be given in the published soil survey report. (These percentages would be calculated during acreage measurements of the map units made from the field sheets.)

4. That proportions of **proceedures** given in the following table be adopted for testing:

1980 WESTERN CONFERENCE **GUIDELINES** FOR PROCEDURES FOR IDENTIFYING THE COMPOSITION OF DELINEATIONS

	Soil	Survey Order	
Mapping Procedure	Order 2	Order 3	Order 4

6. That the procedures for identifying delineations boundaries be adopted for testing.

#### PROCEDURES FOR IDENTIFYING DELINEATION BOUNDARIES

Orders	Boundary Identification Procedure
Order 1	<b>Soil</b> boundaries <b>are</b> observed throughout their length. Air photo interpretation used to aid boundary delineation.
Order 2	Soil boundaries are plotted by observation and air photo interpretation and verified st closely-spaced intervals.
Order 3	Boundaries are plotted by observation and by air photo interpretation verified by sane observations.
Order 4	Boundaries are plotted by sir photo interpretation.
Order 5	Boundaries <b>are</b> plotted by sir photo interpretation.

- 7. That the summary classification table given in Attachment 2 be adopted for testing.
- 8. That the definitions of terms should be an integral part of the criteria for identifying "Kinds of Soil Surveys," and that these definitions be reviewed and amplified by the continuing committee.
- 9. That this committee be continued for the 1984 Western Conference, that it compile a draft document explaining and defining the "Kinds of Soil Surveys" concept in the next few months for testing, that the new committee chairman arrange for field testing starting this '82 field season.
- 10. That Dick Cline be appointed Chairman of this continuing committee for the '84 Conference, and that he choose several committee members to immediately initiate action on testing.

# Committee Members

- S. Brownfield (SCS) \*
- J. Chugg (BLM) R. Cline (FS) \*
- T. Cook (SCS)
- Fi. Dierking (SCS) \*
- 'R. Engel (SCS)
- R. Fenwick (SCS) M. Fosberg (UI) \*
- J. Harman (BLM) Chairman •
- W. Harrison (SCS) •
- L. Herman (FS) \*
- R. Herriman (SCS)
- G. Huntington (UCD) \*
  D. Jones(BIA) •
  C. Landers (FS)

- R. Miles (SCS)
- E. Naphan (SCS) \*
- F. Peterson(UNR)\*
- v. Saladen (BLM) \* D. Smith (FS) •
- G. Staidl (SCS)
- T. Thorsen (SCS)
- In attendance.

#### Committee i

1992 mestern Regional Technical Work Planning Conference of the National Cooperative Soil Survey February 9-13, 1982, San Diego Ca

Tentasive 1992 Termion for Discussion

#### PART I CRITERIA FOR IDENTIFYING XINDS OF SOIL SURVEYS

kands of Sort Surveys	Kings of Map Units	Kinds of Taxonomic Units <sup>2</sup>	Field Procedures 3	Appropriate Field Mapping Scales	Minimum Sice Delineation <sup>3</sup>
Order :	Mainly soil consociations and a few roal complexes	Phases of soil series	The soils in each delineation are identified by traversing or transecting. Soil boundaries are observed throughout their length. Air photo interpretation used to aid boundary delineation.	>1:10,300 <sup>6</sup>	<1.0 acre
Prder I	South considerations associations, and some soil	Phases of soil series	The soils in each delineation are identified by traversing, or observation, or transcating Soil boundaries are plotted by observation	1:10,000 to 1:125,000	1.0 acre to 6.2 acres
Order j	)H				
	complexes		photo interpretation verified by some observations.		
Ordes a	Soli associations and t fen solt consociations	Phases of solutions (i.e.s., or soll subgroups	The soils of defineations representative of each map unit are identified and their proportions and patterns determined by transecting. Subsequent delineations are mapped by observation, or his photo interpretation verified by accessional observations, or hy, traversing. Soundaties are plotted by air photo interpretation.	1:e0.000 to 1:200.000	36 acres 19 399 acres
Orier 3	iori Associations	Phases of soil subgroups. or soil great groups. or soil suborders, or soil orders	The souls, their patterns, and their proportions are identified for each map unit either by supping selected areas -15 to 25 sq. files; by Order 2 survey, or alternatively, by transecting Subsequent supping is by air photo interpretation occasionally verified by observations, or by observation, or by traversing. Boundaries are plotted by air photo interpretation.	1 200,300 to 1:500,000	399 acres to 1,500 acres

<sup>&</sup>quot;Soil surveys of all Orders require maintenance of a soil handbook (legend, map unit descriptions, taxonomic unit descriptions field bole, interpretations) and review by correlation procedures of the National Cooperative Soil Survey. Work plans for a soil survey area may list more than one Order of mapping; the part to which each Order is applicable shall be delineated on a small-scale index map of the area.

Point identifications for a few of the map units of Order 1. 3. 4 — soil surveys hav be hade at higher categorical levels than the componitivonomic unit used for the survey when great soil complexity or low use potential make more specific soil identifications imagoropriate.

Freid procedure terms are defined in Part II of this classification. Publication scale to be chosen to fit the uses

They definition of the men also relikeration, Part III: Guide to Mao Scales and Minimum Site Decimentions.

<sup>\*</sup>Order 1 soil surveys hav be made for purposes that require appraisal of soil areas as small as experimental plots or building states: happeing scale could conceivably be as large as 1:1.

Fig. ( ) in the different is means to include interpretation of any remotely sensed data available.

Table 2-1
Key for Identifying Kinds of Soil Survey

)   14	Level of data needed	Field procedures	Minimum size <u>delineation</u> Hectares 1/	Typical components of map units	Kinds of map units 2/	Appropriate scales for field mapping and Publication	Kind of soil survey
	Very intensive (i.e., experi- mental plots, individual building sites)	The soils in each delineation are identified by transecting or traversing. Soil boundaries are observed throughout their length. Remotely sensed data is used as an aid in boundary delineation.	l or less	Phases of soil series; miscellaneous areas	Mostly consociations; some complexes	1:15,840 or larger	lst order
	Intensive (i.e., general agriculture, urban planning)	The soils in each delineation are identified by transecting or traversing. Soil boundaries are plotted by observation and interpretation of remotely sensed data. Boundaries are verified at closely spaced intervals.	0.6 to 4	Phases of soil series; miscellaneous arces; few named at a level above the series	Consociations and complexes; some undifferentiated and associated	1:12,000 to 1:31,680	Zný order
	Extensive (i.e., range-	The soils are identified by transecting representative areas with	1.6 to 256	Phases of soil series	Noetly associations or complexes; some	1:20,000 to 1:250,000	3rd order
	Extensive (i.e., regional) planning)	The soils are identified by transecting representative great to determine soil patterns and composition of map units.  Soundaries are plotted by interpretation of remotely sensed data.	4D to 4,000	Phases of levels above the series: miscellaneous areas; phases	Heatly associations, some consociations, complemes, and undifferentiated groups	1:100,000 to 1:1,000,000	4th order
	Very extensive (i.e., selec- tions of areas for more intensive study)	The soil patterns and composition of map units are determined by mapping representative areas and applying the information to like areas by interpretation of remotely sensed data. Soils are verified by occasional unsite investigation or by traversing.	1,000 to	Phases of levels above the series; miscellaneous areas	Associations; some consociations and undifferentiated groups	1:500,000 to 1:1,000,000 or smaller	5th order

 $<sup>\</sup>frac{1}{2}$  This is about the shallest delineation allowable for readable soil maps (see table 2-2). In practice, the minimum size delineations are generally larger than the minimum size shown.

<sup>2/</sup>where applicable, all kinds of map units (consociations, complex, association, undifferentiated) can be used in any order of soil survey, and they are not identified as a particular order of map unit.

APPENDIX IV

Phil Derr's Letter



Dr. Richard Cline Chairman, Committee I USDA, Forest Service P. 0. Box 7669 Missoula, MT 59807

Re: Committee !, NCSS, Western Work-Planning Conference

Dear Dick:

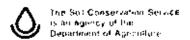
First, I must apologize for not responding to the committee charges in a more timely manner. This last field season has been quite hectic with three comprehensive reviews and three finals. I will try to be as brief as possible in my response to the three charges of this committee even though I feel the charges, as stated, do not adequately cover the guidelines and recommendations discussed in the previous Committee I report.

Charge 1: (Evaluate results of field tests conducted in 1982 and 1983. Revise guidelines, procedures, and definitions as necessary based on these evaluations) We have not used these exact procedures in Wyoming. I feel the documentation that we require of our soil scientists exceeds the recommended procedures for identifying map unit composition at the order 3 level. This is partly due to the fact that we do not accept the field procedural guide as proposed in '82 for the various survey orders. | will cover this more fully in my response to charge 3. I see quite a bit of merit in the use of symbols in identifying the field procedure used to delineate individual map units. We require on site evaluation of each map unit delineation in both order 2 and order 3 soil surveys. Photo interpretation is used as an aid in drafting map unit boundaries on our order 2 and 3 surveys; but composition of the unit is verified by transect, traverse, and field observation of each major soil component. At present, only transects are recorded on the field sheets along with pedon description sites. I'm not sure a national code should be required as long as the individual codes were explained in the survey report.

I do believe we should be more open and explain exactly how we conducted the survey and give an estimate of the limitations of various areas when procedures differ because of potential use.

Charge 2: (Examine the variety of methods available for describing procedure intensity) The different levels of intensity described in the soil mapping system for Canada appear quite similar to our different orders of soil survey. Our orders are in reality general levels of intensity and not kinds of soil surveys. If we wish to use kinds of soil surveys in our guides, perhaps we should go back to the high, medium, and low intensity detailed soil survey, reconnaissance, and exploritory soil survey nomenclature.

The intensity of the soil mapping procedures to be used in an area is dictated by the intended use of the soil survey itself. It may well fall within a set of stated guides or could easily straddle two defined orders on intensity groupings. I keep hearing terms like high order 3 or low order 2. The "work plan" or memo of understanding should state the intensity levels necessary to accomplish the intended needs of each individual soil survey area.



#### 2 - R. Cline - 1/30/84

I really feel we already have enough information relating to intensity and do not need a guide other than the general references in the soil survey manual, National Soil Handbook, and other references such as the Canadian handbook.

Charge: (Produce a revised "kinds of soil surveys" document)

[']] make the assumption here that this charge refers to the document labeled

"Criteria for Identifying Kinds of Soil Surveys." As I have expressed earlier,

I do not agree with the majority of changes made in this document since it was

initially introduced in 1975. The original intent was to define soil surveys as

orders since it was apparent that there was mass confusion in some individual's

minds about the original definition of a reconnaissance soil survey.

Orders 1 through 3 were originally set up to include those surveys called high, medium, by low intensity detailed soil surveys while order 4 was reconnaissance and order 5 was exploratory.

It has seemed to me that the majority of the agencies producing soil surveys have a mystical need to have any survey produced fit into the order 3 conceptual level Thus, the requirements for documentation and intensity of field procedures have been reduced at this level to allow these surveys in. Not all maps produced are soil maps even though soil names may have been used to symbolize the units. Unless soils themselves are the primary criteria used in separating map units, they are not soil maps. Soils are correlated to vegetative groups and other interpretative groups. When the reverse is true, you have an interpretative group or vegetative group map, not a soil map. Unless soils are identified on the site in each delineation of a map unit you cannot, in my opinion, qualify for an order 1, 2, or 3 soil survey. You may qualify for order 4 or 5 but only if soils are the primary basis of the map unit.

There is nothing wrong with interpretative map units, range map units, or woodland map units if they serve a specific need of the user which many do. But we do not change the rules to try to justify calling them soil surveys!

I have made many editorial changes on the proposed criteria for identifying kinds of soil survey submitted by Committee I in 182 on attachment 2 to the W.R.T.W.P.C. report. Some are self-explanitory; others have already been covered under charges 1 and 2.

- 1. If orders are to be retained, instead of calling them kinds of surveys, call them intensities of soil surveys.
- I have taken out a few words and added some under kinds of map units. The
  intensity of mapping dictated in the work plan or memo of understanding will
  cover minimum size of delineations. I added complexes to order 4 since we
  cannot always force nature into our pre-prescribed definitions of kinds of
  map units.
- 3. Kinds of taxonomic units I feel these are adequate for a guide as stated
- 4. Field procedures As you can see, I've reverted to 1975 criteria with some modifications. Reasons have already been stated elsewhere in this paper.
- 5. Appropriate field mapping scales I realize these are only guides, but, as you well know, too many people use them as absolutes! I would recommend an overlapping range to show some flexibility. I'm not hung up on these since they should be a guide. We should not let policy on publication scales

### 3 - R. Cline - 1/30/84

dictate our needs or field mapping scales. Maps should be published at the same scale used in field mapping. Forget cost; we spend hundreds of thousands of dollars producing a usable product and cut hundreds at the end publishing a less than adequate map.

6. Minimum size delineation - Again, these should overlap. Cartographic detail should be consistent with the intended use or needs of the survey. I won't put any limits here since special needs for critical use may require some rather small delineations at any intensity.

I hope this will be of some use, Dick. If you have any questions, give me a call. If you need any help with the final report, feel free to call me.

Sincerely,

Phillip S. Derr

Phy O

Soil Specialist (Correlation)

Attachment

cc: George W. Hartman, State Soil Scientist, SCS, Casper, WY Richard W. Kover, Head, Soils Staff, WNTC, SCS, Portland, OR Glen H. Logan, Soil Correlator, SCS, Boise, ID Possible break down

#### Camittee L

1982 descern Regional Technical Work Planning Conference of the National Cooperative Soil Survey February 3-15, 1982, San Olego Cl

> 1983 Tentative 4000 Vereion for Discutsion

THE THE LATENSING ROCKS A GUIDE TO CRITERIA FOR IDENTIFYING THE OF SOIL SURVEYS!

NIGHSITY af Soil dervers	finds of Neo Units	Kinds of Tironomic Units		ispropriate Fleid Yapping Scales*	Minimum Size Delineztion <sup>3</sup>
Steat : High Intensity	Mathiy foil consociations and a few soul concluses	Phases of soil sector		1:10,300 t	ation ages
modum to		Phases of 1011 series	The soils in each delineation are identified by traversing, or and observation or transecting. Soil houndaries face plotted by observations.	1:10,000 to 1:125,000	1.0 acre to 6.2 acres
Low rall order 5	Soll sasociations, some soli consociations, and a let soli	Sheres of soil series, or soil femilies	The soils in each delineation are identified by traversing and accounting observation, as his photo interpretation, or traversing foundation are consecutively foundation.	1:40,000 1:40,000 1:80,000	delineation 6.2 series to 36 series
Rozonnovica i	zonptez##		photo interpretation verified by 47 sees observerent, moderately 5 paced	intervals by	Keid abservati
Order 4	Soil sysociations and 1 fee soil consociations and complexes	Phases of sol. Camilies, or soll subgroups	The toils of delimentions representative of each map unit are identified and their proportions and patterns determined by transecting, judgequent delimentions are mapped by conservation, or air photo interpretation verified by accasional observations, et al. and by traversing. Foundations are plotted grow by air photo interpretation.	1:60.000 co 1:200.000	36 acres 15 389 acres
Explainter-p occer à	Soil 1910c12cion3	Phases of toil subgroups. or soil frail froms, or soil superders. or soil orders	The noits, their patterns, and their proportions are identified for each map unit either by mapping selected areas (15 to 15 ag. miles) by Order 2 survey, or atternatively, by transecting Subsequent mapping is by air photo interpretation occasionally verified by observations, or by observation, or by traversing. Jaundaries are olotted by air photo interpretation.	1:200,000 to 1:300,000	399 scres (0 2,300 acres

Soil surveys of all Orders require maintenance of a soil handbook (lagend, map unit descriptions, taxonomic unit descriptions, field note, interpretations) and review by correlation procedures of the National Cooperative Soil Survey. Nork plans for a soil survey area may like more than one Order of mapping; the part to which such Order is applicable shall be delineated on a small-scale under map of the area.

Foll : lentifications for a few of the also units of Order 2, 3. I foll surveys may be unde at higher categorical levels than the common taxonomic unit used for the survey when from soil complexity or low use potential make more specific toll identifications inappropriate.

If ald procedure terms are defined in Part II of this classification. "Publication scale to be chosen to fix the uses.

"Sue forinttion of theirum size Salingarion, Part III: Guide to Map Scales and Minimum Site Datineactors.

Porcent soul surviews may be made for purposes that require approxisal of soul areas as small as experimental plots or putiding sames: magnetic scale could conceivably be as large as (it.

Title of the Constitution is meant to include interpretation of any remotely sensed data symplobia.

A Formal correlation Conference will be held on all order 1,2 and 3 intensities of soil surveys. Intermal correlation proceedors will be made on most order 4 and 5 intensities. Some order 4 surveys may recieve a formal Correlation.

# APPENDIX V

1982 Committee I Request for Soil Survey Data

#### MEMORANDUM

To: National Cooperative Soil Survey Members of the Western States

From: Richard G.Cline, Chairman, Committee 1: Application of Field Procedures for Different Orders of Soil Surveys, Western Regional Technical Work Planning Conference of the National Cooperative Soil Survey. U.S. Forest Service, Northern Region, Federal Building, Missoula, MT 59807.

Subject: Field testing soil survey procedures.

The 1982 Western Regional **Technical Work** Planning Conference voted to field test the recommendations of this continuing Committee 1 for field procedures appropriate for the different Orders of soil surveys. If you are able to participate, please notify me and briefly explain the extent of your participation.

The attached documents are intended to be copied by you for distribution to the field parties that will make the actual mapping tests.

To facilitate data collection from field parties under different mapping constraints, we are asking that you choose between these alternative testing procedures; either one will provide valuable information for us:

Testing Procedure 1: Follow the procedures described In (a) Criteria for Identifying Kinds of Soil Surveys,

You will note that the **definitions of the** *transecting* and *traversing* **procedures have been** changed. The second and third alternative definitions of a transect, given in earlier **versions as gridding** or **statistical** sampling, have been deleted. **We** are interested only In transects as a way of systematically recording the location and number of inspections necessary to determine the kind, proportion, and pattern of soil and **nonsoil** components of each delineation.

For

Committe 1: 'Application of Field Procedures for Different Orders of Soil Surveys' 1984 Western Regional Technical York Planning Conference of the National Cooperative Soil Survey

# 1982 FIELD TESTING OF SOIL SURVEY PROCEDURES

- The 1982 Western Conference voted to field test these items involved in rtablishing and applying the criteria for the different Orders of roil surveys and mapping quality control:
  - 1. Test the "Criteria for Identifying Kinds of Soil Surveys" (Table 1).
  - 2. Test the 1982 "Guidelines for Proecdurcs for Identifying the Composition of Delineations" for mapping different Orders of surveys (Table 2).
  - 5. test the 1982 'Procedures for Identifying Delineation Boundaries" (Table 3).
  - 4. Test the recommendation that the procedures for composition-determination and boundary location used to up each delineation be noted by symbols on the field sheets within each delineation for quality control and for record of napping procedures.

These four items can be tested concurrently:

# **Testing Procedure**

- 1. Select a soil survey area for testing. Happing by an experienced party should be in progress. The area tested can be the whole area to be mapped in the remaining field season or parts of it that represent different mapping problems, such as mountainous terrain versus smooth terrain. The area should be large enough to allow the field party to become fully familiar with reporting the procedures they use and to give a reliable measure of the proportions of procedures used--perhaps 30,000 to 100.000 acres.
- 2. Determine the Order of soil survey presently listed in the work plan, then review the criteria for Orders in Table 1 (attached] to see if the two designations agree. You will be asked to comment on the appropriateness of the Order criteria in Table 1 after the field testing is completed.
- 3. Select one or the other of the following basis for testing:
  - Testing Procedure 1: For the Order of survey given in the work plan, follow the criteria and procedures given in attached Tables 1. 2. and 3 as closely as possible even though these procedures are different from those currently being used.
  - Testing Procedure 2: Using the definitions of mapping procedures in Tables 3 and 4 record the procedures currently being used just a8 they are being done and regardless of whether the recommended 1982 criteria fit the claimed Order of survey of the area or not.

4. As each soil delineation on a field sheet is mapped, place permanently-inked symbols on it that indicate both the procedure used to determine soil composition of the delineation (Table 4) and how the delineation boundary was determined (Table 3). Form the symbol from a capital letter, for the composition-procedure, hyphenated to a number, for the boundary-procedure, e.g., "B-3" for "traversed-boundary by mainly air photo interpretation with some observations and soil inspections." Put this symbol below the map unit symbol, but far enough away that the NO won't be confused.

If testing basis #1 was chosen, the surveyor will have to keep running track of the procedures used to map the delineations of a particular map unit so that the required proportions of procedures can be more-or-less achieved. However, it is not mandatory that the proportions be rigidly adhered to (except for minimum transecting, cf., Table 2, footnotes "b" and "c"); the 1982 Western Conference voted that the proportions of procedures for various Orders (Table 2) be considered a policy guideline, not 4 hidebound rule--when 4 survey area, or parts of it. are completed, then the proportions of procedures will be looked at to see how the mapping was done in light of the particular purposes and problems of the survey, and they can be used in the soil survey report to generally describe how the survey was done.

For **transects.** be sure that the location of the transect is shown on the field sheet and that it is keyed to the separate documentation of the transect with a symbol, e.g., "T-73."

For traverses, be sure that each site of an Inspection of all the significant horizons of a component soil by auger or shovel is shown on the field sheet with a small circle or other symbol. For traverses, each kind of component soil has to be inspected and noted somewhere in the delineation or else the mapping procedure becomes an "observation."

The definitions of mapping procedures might be interpreted to mean that only one transect. traverse, observation. or inspection, per delineation is necessary; however, this may or may not be the case. Committee 1 has not considered whether or not only one. or for very large delineations, more than one traverse, observation, etc., should be made. This remains a matter of judgement for the surveyor. When more than one transect or traverse is made In a delineation, the symbols for the transect location or soil Inspections along a traverse will show the fact for quality control review. You may wish to use some additional symbolization to show where additional observations, or observations alone were used. Please consider this problem for later comment.

- 5. When a field sheet, or the appropriate test-area, is completed, fill out a "Field Sheet Record" form. List separately for each delineation tested the procedures used to identify the delineation and the procedures used to determine tts boundary. Write down any additional comments or observations on the test on the back of the form.
- 6. When all of the mapping testing is completed, please discuss the test among the field party and prepare any comments that may be helpful.

Send a copy of all "Field Sheet Record" forms, sample of any transect record forms used, with instructions, and any comments you have to R. G.Cline, Chairman, Committee 1.

#### Table 1

#### Committee L

ESEZ mestern Regional Technical Work Plenning Conference of the Nazional Cooperative Soil Survey February 8-22, 1982, Sen Diego Ck

#### 1931 Vermion

# CRITERIA FOR IDENTIFYING EINDS OF SOIL BURNEYS?

Kinds of Soil Surveys	Kinds of Map Units	tinds of Texanomic Unite <sup>2</sup>	Field Procedures 1	Appropriate Field Mapping Scales	Minimum Size Delinestron <sup>5</sup>
Order 1	Mainly soil consociations and a few soil complexes	Fhases of soil sories	The soils in each delinestion are identified by traversing or transacting. Soil boundaries are observed throughout their length. Air photo interpretation used to aid boundary delineation.	>E:10.000 <sup>6</sup>	<1.0 écre
Or447 2	Soil consociations, associations, and some soil completes	Phases of soil series	The socis in each delineation are identified by traversing, or observation, or transecting. Soci boundaries are plotted by observation and all photo interpretation and verified at closely spaced intervals.	1:10,000 to 1:25,000	1.0 agre so 6.2 agres
Order 5	Soil misociations, some soil consociations, and m few soil complexes	Phases of soil enties, or soil families	The soils in each delineation are identified by traversing, or observation, or air photo interpretation, or transpecting Sounderies are plotted by observation and by air photo interpretation verified by some observations.	1:25,000 to 2:60,000	6.2 acres 36 acres
Order 4	Soil associations and a few soil consociations	Shases of soil families, or soil subgroups	The soils of delimations represen- tative of each map unit are identified and their proportions and patterns determined by transecting. Subsequent delimations are supped by observation, or air photo interpretation verified by occasional observations, or by travarsing. Boundaries are piotted by air photo interpretation	1:60.000 to 1:200,000	36 acres to 399 acres
Grass 2	Soll Busociations	Phases of soil subgroups, or soil great groups, or soil suborders, or soil orders	The soils, their patterns, and thrir proportions are identified for each map unit either by mapping selected areas (15 to 25 sq. siles) by Order 2 survey, or alternatively, by transacting Subsequent mapping is by air photo interpretation occasionally verified by observations, or by observation, or by irraversing. Boundaries are piotted by air photo interpretation.	1:200,000 to t:500,000	399 acres to 2,500 acres

Soil surveys of all Orders require maintenance of a soil handbook (legend, map unit descriptions, texonomic unit descriptions field more, interpretations) and review by correlation procedures of the National Cooperative Soil Survey. Note plans for a soil survey area may list more than one Order of mapping; the part to which each Order is applicable shall be delineated on a small-scale index map of the area.

Fool: identifications for a few of the map units of Order 2, 3, 4, and 5 soil surveys may be made at higher detegorical levels than the common taxonomic unit used for the survey when great soil complexity or low use potential make more specific soil identifications insopropriate.

Ifield procedure terms are defined in Part II of this classification "Publication scale to be chosen to fit the uses

See definition of minimar size delinegation, Part III: Guide to Map Scales and Minimum Size Delineations.

<sup>\*</sup>Order 1 coll curveys may be made for purposes that require appraisal of coll stems as small as experimental plots or building sizes; mapping scale could conceivably be no large as 1:1.

Two phase interpresention is meant to include interpretation of any remotely sensed date evaluable.

Table 2

1982 WESTERN CONFERENCE GUIDELINES FOR PROCEDURES FOR IDENTIFYING THE COMPOSITION OF DELINEATIONS

Manning Drogadura	Soil Survey Order					
Mapping Procedure	Order 2					
	• of deline	eations of each m	ap unit=/			
(A) Transecting	5 <u>b</u> /	5 <u>c</u> /	5 <u>ċ</u> /			
(B) Traversing	75	40	15			
(C) Observation	20	40	40			
(D) Air Photo Interpretation	0	15	40			

In application, the percentage (\$) of a delineation will vary several percentage points. A single number, rather than a range, is assigned in this table to maintain clarity of the relative proportions of the procedures.

b/Micionion

Table 3

1982 HAPPING PROCEDURES FOR IDENTIFYING DELINEATION BOUNDARIES'

Procedure No.	Boundary Identification Procedure
1	Soil boundaries are observed throughout their length and verified frequently by soil inspections on both sides of the boundary. Air photo interpretation is used to aid boundary delineation.
2	Soil boundaries are delineated by about equal application of observations and air photo interpretation with regular verification by soil inspections on both sides of the boundary.
	Boundaries of delineations are plotted by mainly air photo interpretation with some observations and verified by some soil inspections accompanying determination of the soil composition of the delineations.
	Boundaries of delineations are plotted by air photo interpretation with only occasional observations and verifications attendant on determination of the soil composition of the delineations.
5	Boundaries of delineations are plotted by air photo interpretation.

<sup>&#</sup>x27;This is an amplification of the condensed procedure descriptions approved by the 1982 Conference.

## Table 4

# 1982 DEFINITIONS OF MAPPING PROCEDURES FOR IDENTIFYING THE

# COMPOSITION OF DELINEATIONS'

A. Transect: The field mapping procedure that consists of making field Inspections while crossing a circumscribed area in a straight or irregular line to determine the kind, proportion, and pattern of soil and nonsoil components from their occurrence on the line. By component we mean a natural body of any size that is necessary to Identify a delineation as being a member of a defined or proposed map unit.

Transects require explicit documentation keyed to location on a field sheet by a symbol (e.g., "T-73"). A transect record should be prepared and include (1) map unit name and symbol, transect number, field sheet identification symbol and scale, (2) physiographic position of the delineation, (3) the identification of each component, (4) the proportion of each component, (5) the pattern of the components, (6) the vegetation, geological material, and physiographic position of each component, (7) the major surface features that helped in placing boundaries between components, (8) a planimetric sketch of the transect showing the route, location of inspections, transect boundaries between components, and important surface features, and (9) a cross-sectional diagram sketch showing the relation of components and important surface features, vegetation, and geology to landforms.

A transect is most simply accomplished along a straight line of travel if it can be selected to cross representative soil components. But, one may also be done along an irregular line of travel If it better represents soil components or is forced by phycical difficulties of travel, In mountainous terrain a transect may have to be pieced together from several entry points. The essential feature of a transect is that it provides a record of a detailed study of a narrow belt in a geographic area in order to Identify a delineation or define a map unit.

The component soils are identified from auger or shovel-hole excavations made in different soil bodies as they are encountered along the line of travel. An identification by the taxonomic class used in the survey is sufficient; critical soil characteristics or environmental features may be noted, or complete soil descriptions may be written at one or more inspections sites along the transect if desired, but they are not mandatory for the transect procedure per se. Nonsoil components are identified by the attributes that define them. Each inspection site should be marked with a circle on the planimetric transect sketch.

<sup>1</sup> This is an amplification of previous procedures for the purposes of this field test.

The proportions of various components can be calculated from simple pacing measurements for straight-line transects. For transects along irregular lines of travel, partial-boundaries between components should be sketched on the field sheet and proportions calculated from intercepts along a straight line, or lines drawn on the field sheet and measured with a ruler.

Air photo interpretation is used to help locate separate bodies of soil *or not* soil on the line of transect. All likely components are ground-checked and identified by inspection.

B. Traverse: The field mapping procedure of determining the kind, proportion, and pattern of components in a delineation by entering or crossing it along a line of travel selected to intersect Its various components. The soil components are identified from auger or shovel-hole excavations. Locations of soil inspections along the traverse line are marked on the field sheet with a small circle or other symbol. No other written documentation is required for the traverse procedure. Commonly, field notes are made at some of the soil inspection sites which increase the value of a travere.

Traverses are the principle method whereby the surveyor correlates the location of surface features of landscapes with the location of different kinds of soils. Thesekinds of correlations eliminate the need for extensive sampling of landscapes to determine the distribution of soils and give credibility to the idea that the location of soils can be predicted from known , soil-landscape relationships.

C. Observation: The field mapping procedure of being on-the-ground and visually inspecting at selected sites landscape features, exposed geological formations, and chance exposures of soil horizons or soil materials in order to identify delineations from previously determined relations.

Identification of component soils by observation may use <code>air</code> photo interpretation, but requires an additional on-the-ground view close enough that individual shrubs, atones, and chance exposures of soil horizons or materials can be seen clearly, i.e.. closer than a hundred yards or so. Air photo interpretation alone or views from aircraft are not "observations." Since observations are made on-the-ground, there is the possibility of further checking a feature by a quick soil inspection. Many observations include quick or <code>partial</code> soil inspections. If the inspections do not include all significant horizons, or each kind of component soil in a delination, or all of the soil inspection sites are not indicated in the delineation on the field sheet, then the procedure is an observation, not a "traverse."

D. Air Photo Interpretation: The office or field mapping procedure of plotting soil boundaries and predicting the soil composition of delineations based on interpretations of air photo features that have been previously correlated with local soil and landscape features. Air photo interpretation. as the term is used here, includes the interpretation of all applicable remote sensing imagery.

Air photo interpretation is a strictly intellectual, second-hand conclusion based on previous correlation of landscape features visible as air photo features with soils. In comparison, an "observation" is a concrete, novel experience that can identify many more positive landscape-soil relationships. Air photo Interpretation involves the correlation of photo features with landscape surface features. An observation traverse or transect involves the correlation of soil features with landscape surface features. One might visualize the relationships as follows:

Soilfeatures landscape surface features photo features

The correlation between soil features and photo features can only be good when landscape surface features have a good correlation with <u>both</u> soil and photo features. One can see that air photo interpretation is actually one step removed from the field procedures.

As with many observations, the rationale for local air photo interpretations is seldom documented or explained in any local survey records, so there are few or no standards for evaluating an interpretation other then field inspection. Compared with air photo Interpretations, interpretations from observations are apt to be better because they are based directly on soil and landscape features rather than those Indirect features visible on air photos.

# 1982 Field Test of Soil Survey Mapping procedures

# Test Baste:

- ( ) Test Procedure 3
- ( ) Test Procedure 2

# FIELD SHEET RECORD

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<ol> <li>Use symbol in identification legend. Provide copy of I.D. legend.</li> <li>Determine size of delineation.</li> <li>Kind of map unit: CR, consoristion; CR, complex; AN, association; UG, undifferentiated growth of the procedure. Use A, B, C, or D as defined in Table 2 and 4.</li> <li>Boundary identification procedure. Use 1, 2, 3, 4, or 5 as defined in Table 3.</li> <li>The number of field inspections in making a transact, traveres, observation, or air photo</li> </ol>												
<ol> <li>Use symbol in identification legend. Provide copy of I.D. legend.</li> <li>Determine size of delineation.</li> <li>Kind of map unit: CR, consoristion; CR, complex; AN, association; UG, undifferentiated growth of the procedure. Use A, B, C, or D as defined in Table 2 and 4.</li> <li>Boundary identification procedure. Use 1, 2, 3, 4, or 5 as defined in Table 3.</li> <li>The number of field inspections in making a transact, traveres, observation, or air photo</li> </ol>												
<ol> <li>Use symbol in identification legend. Provide copy of I.D. legend.</li> <li>Determine size of delineation.</li> <li>Kind of map unit: CR, consoriation; CR, complex; AN, association; UG, undifferentiated growth and interesting procedure. Use A, B, C, or D as defined in Table 2 and 4.</li> <li>Boundary identification procedure. Use 1, 2, 3, 4, or 5 as defined in Table 3.</li> <li>The number of field inspections in making a transact, traveres, observation, or air photo</li> </ol>		I										
<ol> <li>Kind of map unit: CN, consoristion; CN, complex; AN, association; UG, undifferentiated growth.</li> <li>Identification procedure. Use A, B, C, or D as defined in Table 2 and 4.</li> <li>Boundary identification procedure. Use 1, 2, 3, 4, or 5 as defined in Table 3.</li> <li>The number of field inspections in making a transect, traverer, observation, or air photo</li> </ol>	1) Dec 1	ymbol in	identific		vide copy of I.	D. legend.						
5) Boundary identification procedure. Use 1, 2, 3, 4, or 5 as defined in Table 3.  b) The number of field inspections in making a transect, traveres, observation, or air photo	3) Kind	0 849 UT	ait: Ot.	composintion; CK,	complex; AN, se	sociation; DG,	undifferentiated group.					
	5) Bown	Sary Ideni	lification	procedute. Use l	, 2, 3, 4, or S	as defined in	Table 3.					
				,,,,,,,,			and the second					
est Basis: In the upper left corner, check off the basis of the test:	aat Basi:											
"Testing Procedure 1" means that the mapper attempts to achieve the proportions of composition-procedures suggested in Table 2 for the Order of soil survey that the particular survey is claimed		the pr	ropertions	of composition-pr	acadures sugges	ted in Table 2						

is made, and regardless of the proportions suggested in Table 2.

The "Soil Survey Order" given in the general information section should be that identified in the MUSSA.

# Committee 2: Application of Laboratory Methods to Soil Classification and Agronomic Interests

Chairman: William Alardice - Chairman

G. Brockman (BR) M. Fosberg (UI) O. Harju (BR) H. Ikawa (UH)

D. Jones (BIA)D. Nettleton (NSSL)

D. Nettleton (NSSL J. Nielsen (MSU)

J. Simonson (OSU)
A. Southard (USU)

Clifton Deal (SCS-WVTC)

# **Charges:**

- (1) Review current methods of soil analyses with respect to their effectiveness in identifying soil properties.
- (2) Evaluate new methods of soil analyses and make recommendations to the Western Regional Work Planning Conference.
- (3) Communicate problems and solutions to problems encountered in soil characterization analyses.
- (4) Establish minimum standards for laboratory procedures.

# COMMITTEE

Charge 1-

Charge 2 -

Charge 3 -

Charge 4 -

- may be required before achieving equilibrium at 15 bars pressure on the 15 bar ceramic plate extractor or the pressure membrane  ${\it aparatus}$ .
- **8.** The Committee should continue with the original charges, members and chair.

# COMMITTEE 2 REPORT Committee on Laboratory Methods

The University of Alaska, California and Utah and the National Soil Survey Laboratory participated in comparison of some laboratory procedures during the past two years.

# 15 Bar Ceramic extractor

VS

# Pressure Membrane Apparatus

The conclusion reached by Utah and California was that either apparatus was suitable for determination of 15 Bar moisture content when adequate time was allowed (48 to 100+ hr depending on texture) for equilibrium to be reached and when suitable means of detecting equilibrium was used which prevented evaporation of the effluent water. 15 bars and 15 atms have been used interchangeably over the years as 220 lbs pressure so that specifying the pressure in pounds would help clarify the procedure used.

15 atms = 14.696 x 15 = 220.0 lbs/sq in pressure

15 bars =  $14.504 \times 15 = 217.6 \text{ lbs/sq}$  in pressure

1 bar =  $10^5$  Pa (Pascal)

15 bars =  $15 \times 10^5$  Pa, 1.5 MPa

CEC

Alaska NSSL UCD

CEC was run on samples supplied by the participants with no inter laboratory exchange. Each laboratory experienced differences between the methods with  $BaCl_2$ -Tea 8.2 titration being the most variable. No single method was satisfactory in all cases. The analyses were referred back to the labs for further study. Problems continue in soils with variable charge, according to Dr. Ikawa of Hawaii, and with other techniques, i.e., excess NH, has not been completely removed when washing in the NH4OAC method.

# Particle Size - Dispersion Methods UC

In the tests that were conducted there were very small differences between the treatments, less than was expected, so the analyses has been referred back to Committee for further evaluation over a greater variety of textures and O.N.

The Committee has elected to analyse one or two B horizons from each participating laboratory. Samples are to be collected, prepared and shipped by Sept. 84. Analyses for % Base Saturation and Particle Size Analysis are to be completed by Sept. 85.

Methods - Triplicate-

CEC NH<sub>4</sub>OAc

BaCl2 · TeapH 8.2 Titration t Extractable Cations

KC1 Al + Extractable Cations

Your own method

Dispersion

ASTM

NSSL

Your own method

The latest  ${\tt SSIR}$  and the 1972 SSIR  ${\tt\#1}$  from the NSSL will be used as references -

Participants will he mailed copies of the procedure so that we will be able to follow the same procedures in each laboratory.

Participating Laboratories (identified at this time)

Alaska	Florida				Montana
Arizona	Geological	Survey,	Washington,	D.C.	Oregon
BIA	Guam				Utah
California	Hawaii				Washington
Colorado	Idaho				Wyoming

# UTAH STATE UNIVERSITY College of Agriculture

						1		<del></del>
Location	USU Log #	Ident	Sample depth (in)	<b>%</b> by (15	mass 1/3 bars)	sture at 15 atmos	Hydromet Sand Silt	

# 15-Bar Comparison University of California Samples

NSSL No .	Calif. No.	15-B NSSL	ar, % Calif.	NSSL No.	Calif. No.	15-6 <b>NSSL</b>	Bar, % Calif.
NO .		11332	001111		1,0.	NOOL	001111
82T7274	1097-6	17. 0	18. 5	<b>82</b> T7 <b>3</b> 23	1408-6	15. 3	17.4
82' 17275	1118-5	13. 6	13. 5	82T7324	1408-8	20. 1	21. 5
8277276	1208-2	7.6	9.8	82T7325	1408-9	<b>23.</b> 3	24. 8
82T7277	<b>1208</b> - 3	7.3	8.5	82T7326	1409-3	15. 1	15.4
8217278	1226-5	18.9	19.8	82' 17327	1420-4	14. 3	"14. 8
82T7279	1242-1	14.7	15.8	82T7328	1420-5	18. 2	16. 4
82T7280	1242-2	12.6	13.0	82T7329	1421-l	24. 2	29. 2
82T7281	1242-3	12. 8	13. 0	82T7330	1421-Z	23. 9	30. 4
82T7282	1252-l	5.5	6.7	82T7331	1421-3	24.7	31. 1
82T7283	1269-6	16.6	17.7 11.8	82T7332	1422-6	24. 5	26. 6 25. 3
82T7284 82T7285	1270- 4 1270- 5	8.6 7.3	10.7	8277333 82T7334	1422-7	23.0	23. 3 21. 8
8217285	1270- 5 1271- I	13.1	10. 7 17. 6	82T7335	1424- l 1424- 3	15. 8 14. 3	13. 4
82T7287	1271-1 1271-Z	12.1	17. 8	82' 17336	1424-3 1424-4	14. 3 12. 2	14. 0
82T7288	1301-1	6. 2	8.4	82T7337	1424-4 1424-6	12. 2 12. 0	13. 9
82' 17289	1301 - 2	6. 5	8.0	82T7338	1424-7	11. 0	11.9
82T7290	1301-3	7.4	8.8	82T7339	1424-8	9.9	9.6
82' 17291	1301-4	7.7	9.8	82T7340	1426-4	25.2	26.4
82T7292	1305- l	19.0	21.3	82T7341	1426-5	27: 0	29. 0
82' 17293	1306- Z	10. 3	10.6	82T7342	1429- l	19. 2	19. 4
82T7294	1311-l	5. 6	7.0	82' 17343	1429-2	21. 2	21.8
82T7295	1311-2	4. 9	5.6	<b>82</b> T7344	1430-6	25.3	24. 3
82T7296	1311-5	7.9	8.7	82T7345	1431-l	10. 5	12. 2
82T7297	1331-4	22.0	22.5	82T7346	1431-2	8.4	9.6
82T7298	1331-6	23. 2	23.6	8217347	1432-5	22.6	25.7
82T7299	1332-2	3.2	4.0	82T7348	1432-6	22. 5	
8217300	1339-2	18.3	19.0	82T7349	1447- l	6. 2	
8277301	1339-3	20. 1	21: o	82T7350	1447-2	6.7	
82T7302	1342- l	21.4	23. 1	82T7351	1447-3	8.2	
8217303	1349- l	21. 6	25. 5	82T7352	1450- l	27.6	
82T7304	1349- Z	25.3	27. 3	8217353	1450-2	25. 9	
82T7305 82T7306	1352-l	13.7	<b>20.3</b> 18.8	82T7354	1450-3	<b>26</b> . 7	
8217305 8217307	1352- Z 1389- 2	12. 5 11. 6	14.5	8217355	1480-5	15. 1	
82T7308	1394- Z	11. 0 13. 9	16.7	82T7356 82'17357	1487- 5 1489- l	15. 1 2. 6	
82T7309	1400- l	19. 4	24.7	82T7358	1488-2	2.8	
82T7310	1400 - 2	15. 5	20.0	82T7359	1492- l	5.7	
82T7311	1400-3	17.6	20. 8	82T7360	1492-2	6.1	
8217312	1401- l	13. 9	lb. 1	8217361	1494- l	16.9	
82T7313	1401-2	15. 0	18. 2	82T7362	1494-2	17.3	
82T7314	1401-3	15. 0	21. 0	82T7363	1494-3	19.1	
82T7315	1401-4	18. 4	23. 0	82' 17364	1498-4	17.5	
82T7316	1401-5	22.8	29. 6	82T7365	1498-6	25. 4	
82T7317	1401-7	30. 8	<b>36.</b> 3	82T7366	1498-7	20.6	
82T7318	1407-l	12. 3	13. 2	82T7367	1427-Z	18. 6	
82T7319	1407-2	14. 6	15. 4	<b>82</b> T7368	1321-3	4.9	
82T7320	1407-3	14. 9	15. 7	82T7369	1230- l	14.2	
8217321	1408- l	12.7	14. 4	8277370	1230-2	14. 4	
82T7322	1408-2	12.8	13. 3	82T7371	1230-4	20. 2	

	Series/Pedon <b>No./Project</b>	D≏oth	Hori zon	LSL No.	Consc. No.	15-Bar, Pct. NSSL UC Davis		
	Wrightsville, S79LA-097-008 (CP80-LA077)	o- 14 14-29	AP B1	80P0643 80P0644	33 34	6.9 6.4 7.7 a.2 7.8 7.6 9.4 9.5	2 - 8.2	3
		29-48 <b>48-69</b> <b>69-91</b>	B21T B22T B23T	80P0645 80P0646 80P0647	35 36 37	12.0 11.7 13.5 - 12.2 12.1 14.2 - 13.9 14.3 16.2 -	11. 7 12. 2 15. 6	
	Adlar S80MS-083-002 (CP80-MS236)	0-20 <b>20</b> -76 76-91 91-117	C1 C2 C3 C4	<b>a0P1732</b> 80P1733 <b>aoP1734</b> 80P1735	38 39 40	4.3 4.3 4.7 4.4 5.6 5.6 6.2 6.5 17.8 18.0 19.3 7.9 26.2 26.4 27.2 28.5	4. 2 5. 5 18. 7	- 18.6
		91-117 117-152	<b>C4</b>	80P1735	41 42	32.7 32.0 35.6 32.8	30. 4	35. 0
	Wahee, S80NC-085-003 (CP80-NC295)	o- 11 11- 29 29- 43 43- 65	A1 A2 B21T B22T	<b>aoP2699</b> 80P2700 80P2701 80P2702	43 44 45 46	11.8 11.1 15.9 - 5.7 5.7 7.1 a.2 9.4 9.0 9.7 10.5 13.9 13.3 14.9 -	14. 7 6. 1 9. 4 13. 5	
75	Throck, 5801X-417-001 (CP80-TX207)	0- 10 10- 29 29- 50 53- 66 66- 87	All - Al2 B21CA B22CA B23CA	80P1472 80P1473 80P1474 80P1475 80P1476	47 48 49 50 51	15.1 15.0 17.7 - 14.8 14.8 17.2 - 14.6 14.4 16.3 - 14.7 14.7 16.0 - 14.9 15.1 17.6 17.0	16. 2 15. 4 15. 1 15. 5 15. 5	15. 6 15. 0 16. 4 16. 3 17. 0
	Monona. SROIA-155-001	o- 5 5- 20 20- 35 35-50	Ap1 Ap2 <b>A3</b> Cl C2	81P2169 81P2170 ai P2171 81P2172 81P2173	52 53 54 55 56	12. 5 11. 9 15. 8 15. 6 13. 4 12. 8 16. 7 16. 9 13. 0 13. 1, 17. 8 18. 0 12. 1 12. 6 16. 2 16. 8 11. 8 12. 5 17. 0 17. 3	13. 1 13. 9 13. 8 13. 6 13. 5	14. 6 15. 7 16. 3 14. 6 13. 5
la&b-Two repl 2-Single run	Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Solvery Sauth Solvery Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sauth Solvery Sa		Ap A12 B21T B22T B23T	<b>B0P0578</b> 80P0579 80P0580 80P0581 80P0582	57 58 59 60 61	8.3 7.9 10.4 9.8 8.7 8.3 1.0 10.5 12.8 12.2 5.9 15.6 14.1 13.5 7.6 17.0 14.1 13.5 5.9 15.6	8. 2 8. 4 13. 2	13.0 - 13.8
3-Spot check 4 and 2	WWW.	Od J	AP B21T B22T <b>B3</b>	80P0361 80P0362 <b>a0P0363</b> <b>aoPo364</b>	62 63 64 65	10.6 9.9 11.8 - 20.1 18.6 22.2 - 19.9 18.6 22.5 - 17.4 16.5 21.1 -	10.6 19.2 18.1 18.1	20. 0 17. 8

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Series/Pedon No./Project	Deptin	Hori zon	LSL No.	Cotlsc. No.	15-Bar, Pct. NSSL UC Davis	
W_1 _ 07000 071 001		41	0001250	47	la lb 2	3
Kyle, \$79\$D-071-001	o- 5	Al	80P1358	67	19.2 20.3 26.2	
(CP80-SD202)	5-15	B1	80P1359	68	<b>22.0 22.2 27.6 - 21.9</b>	22.0
	15-33	B21	80P1360	69		23.8
	33-50	822	80P1361	70		22.9
	50-71	B3	80P1362	71	20.4 20.9 24.1 - 21.2	-
Menominee, S81WI-075-001	o- 3	Al	81P1529	72	14. 0 13. 8 19. 9 24. 7	-
-=(RP8T-WI150)	3- b	<b>A2</b>	81P1530	73	3.3 4.1 5.2 5.7 4.4	_
·	8-43	B211R	81P1531	74	2.2 2.2 2.7 2.6 2.4	-
	43-84	B22IR	81P1532	75	1.2 1.3 1.4 1.3 1.2	
	84-94	A & B	81P1533	75	1.9 1.9 2.5 3.0 2.1	_
Lab Checks -BIA	46-63	6-3	81P0987	77	5.1 5.2 5.8 5.4 5.4	_
(RP81-AZ102)	8-23	0 0	81P0988	78	3.4 3.4 4.1 3.8 3.3	
( , , , , = , , = , , , , , , , , , , ,	79-107	29- 4	81P0989	79	2.6 2.5 3.0 2.8 2.5	_
	23-107	36-3	81P0990	80	3.7 3.8 4.5 - 3.7	
	13-20	37-3	81P0991	81	14.8	_
	28- 109	49-3	81P0992	82	14.7. 14.6.16.4 16.3 - 3.4	Ξ
	25- 7 <b>6</b>	50-3	81P0993	83		9.3
	25-41	52 <b>-</b> 3	81P0994	84	1.5 1.4 2.1 2.1 1.6	13.3
	41- 195	52-3 52-4	81P0995	85		
	41-193	3 <b>2-4</b>	0170333	<b>6</b> 2	1.7 1.8 2.5 2.3 2.0	-
Redvine, S79CA-045-025	0-8	All	80P2931	86	8.7 8.7 9.6 9.6 -	_
(CP80-CA300)	8-20	AB	£73(55 <b>0</b> F	87	8.9 8.9 9.2 9.5 9.4	
•	20-36	B21T	801' 2933	88	107 10.6 11.0 - 11.0	-
	<b>36-76</b>	B22T	80r2934	89		8.7
	76-99	B23T	80P2935	90		17. 3
	99-127	B24T	80P2936	91	16. 3 16. 4 16. 5 17. 2	_
Winteridge, S80UT-047-003	0-10	Al	80P2773	92	8.4 8.7 10.1 10.6 9.3	-
(CP80-UT296)	10-21	B21T	80P2774	93	9 6 11.3 11.1 10.2	_
, , ,	21-31	B22TCA	80P2775	94		2.4
	31-46	B3CA	80P2776	95	12.5 11.3 12.2 11.3 13.6 13.4 12.8	
	46-89	CICA	80P2777	96	12. 2 11. 9 12. 7 - 12. 3	-
Crinker, S81WA-073-013	36-0	02	8123101	97	73. 9 76. 8 89. 6 88. 0 17. 0	_
(CP81-WA239)	0- 18	A21	81P3102	98		6.7
for an integral	18- 3 <b>6</b>	A22	81P3103	99		6. 1
	36- 5 <b>8</b>	3HI R	81P3104	100	21. 7 22. 0 26. 8 25. 4	
	58- 114	BIR	81P3105	101	15. 4 14. 6 15. 4 13. 9 13. 7	_
	00 111	J 4 14				

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INTERLAB **SAMPLES:** 15-Bar Comparison

Series/Pedon No./Project	Depth	Hori zon	LSL No.	Consc. No.	15-Bar, Pct. NSSL UC Davis
Becket, S79ME-017-001 (CP79-ME235 - <b>Library)</b>	o- 5 5- 26 64- 80	A2 B211R Cl	79P2000 79P2001 79P2002	1 2 3	1a lb 3 3.8 4.4 5.6 6.1 42.6 6.8 6.6 8.9 - 7.3 1.5 1.4 2.0 1.8 1.5 1.5
<b>Bartley</b> , \$78NJ-027-001 (CP80-NJ015)	0- 28 28- 61 61- 76 76- 117 117- 193	AP B2 Bxl Bx2 Cx	<b>S0P0064 S0P0065</b> 80P0066 80P0057 80P0068	4 5 6 7 8	7.8 7.2 8.8 - 7.7 7.2 7.6 9.0 <b>8.9 180.6</b> - 9.3 11.3 10.9 12.4 - 10.6 11.1 10.2 12.0 - 10.0
NESCS <b>Study</b> (RP81-PA274)		11 12 13 14 15 16 17	81P4012 81P4013 81P4014 81P4015 81P4016 81P4017 81P4018 81P4019	9 10 11 12 13 14 15	18. 1     18. 8     21. 3     -     19. 0     20. 0       13. 7     13. 8     15. 2     -     13. 5       8. 8     8. 6     9. 4     10. 5     9. 2       15. 0     14. 9     15. 3     15. 1     15. 1     15. 4       7. 8     7. 8     9. 6     9. 1     8. 4       10. 0     10. 1     10. 5     10. 4     10. 4       22. 1     21. 8     21. 7     23. 7     21. 9       4. 7     4. 8, 5. 1     6. 2     4. 3
<b>Minesoil</b> , \$75WV-061-002 (CP81-NL168) <b>NE-96</b>	o- 5 5- 13 10-25 25- 50 50-81	A1 A3 C1 C2 C3	81P1792 81P1793 81P1794 81P1795 81P1796	17 18 19 20 21	7.7 7.5 8.2 9.2 8.0 7.8 7.9 7.9 8.6 9.3 8.4 8.4 8.4 8.4 8.4 8.4 8.7 9.1 10.2 9.1 8.8 8.7 9.3 11.2 9.2
Iredell, S77MD-031-001 (CP81-NL168) <b>NE-96</b>	0-11 11-18 18-29 29-45 45-54	A1 A2 B1 B21t B22t	81P1838 81P1839 81P1840 81P1841 81P1842	22 23 24 25 26	7.9 8.1 9.0 11.2 9.5 7.1 6.9 8.0 9.5 - 10.4 10.5 10.6 11.8 10.6 16.9 16.2 17.3 18.5 17.5 16.6 18.3 18.5 19.6 20.5 19.9 19.6
Troup, \$80GA-243-003 (CP80-GA163)  la&b-Two replication of 36 Hr equilibrium 2 - Single run of equilibrium run - 48-96 h 3 - Spot check of 15 bars vs 15 atms used on #1 and 2	100-126 126-139 139-157 157-182 182-322 ars.322-352	A2 & 81 B1 & A2 B21 B22 B23T 2B24TB	SOP1074 SOP1075 SOP1076 80P1077 SOP1078 SOP1079	27 28 29 30 31 32	3.8       3.6       3.9       3.8       3.7       3.7         7.7       7.7       8.1       8.1       7.7         12.8       12.5       12.7       12.6       13.6         13.4       13.4       13.9       13.9       13.6         12.6       12.5       12.7       12.6         17.6       17.9       18.4       17.9       18.0

TABLE 1. CEC DETERMINATIONS OF SOME ALASKAN SOILS FORMED IN VOLCANIC ASH

			ŗ	——— Н	Cation	Exch	ange C	apacit <u>y</u>	
Sample Number	Soi l hori zon	Texture class	1:1 H <sub>2</sub> 0	CaCl .01M <sup>2</sup>	NH OAC CHOI(+	Na <u>O</u> Ac ∙)kg (r	BaC12 neq100gr	NH CT	Classification
1	E	sil	5. 0	4. 2	33. 2	30. 6	19. 0	: 11.8	Typic Cryorthod,
2	Bsl	sil	6.0	5.3	22.4	25.3	16. 3	10.3	Medial over sandy
3	Bs2	sil	6.0	5.1	13. 9	14.4	11.5	5.3	or sandy-skeletal,
4	ВС	sil	6. 1	5. 0	7.6	9.0	8.0	3.2	mi xed
5	E	sil	4. 5	3. 7	12.9	13.7	13.6	8.5	Typic Cryortbod,
6	Bsl	sil	5.5	5. 0	10.9	11.7	14.4	4.1	Medial over sandy
7	Bs2	sil	<b>5.8</b>	5. 1	23.8	23.2	le.4	12.1	or sandy-skeletal,
8	Вс	sil	5. 1	4. 5	50.5	50.1	50.3	17.4	mi x
9	E	vfsl	5. 2	4. 5	31.6	21.3	21.1	9.0	Typic Cryorthod,
10	Bs	sil	5.8	5.0	48.4	33.8	25.4	13.7	Medial over loamy,
11	Bw	sil	6. 2	5. 6	21.4	16.3	11.5	8.0	mi xed
12	E	sil	4. 9	4. 2	43.9	24.6	25.4	11.1	Typic Cryorthod,
13	Bs	fsl	6. 2	5.3	57.4	42.0	26.7	16.5	Medial over loamy,
14	Bw	sil	6. 1	5. 4	37.6	20.3	17.8	9.2	ni xed
<b>I</b> 5	0-8"	vfsl	4. 5	3. 7	71.5	39.2	63.6	28.4	Typic Cryorthod,
16	Eb	vfsl	4.6	3.7	22.4	24.4	18.4	10.4	Thixotropic over
17	Bhsb	sil	5. 1	4. 1	60.3	69.5	30.2	19.9	loamy, mixed
18	Eb	vfsl	5. 0	4. 1	32.0	35.0	18.2	15.3	Typic Cryandept,
19	Bsb	sil	5. 1	4. 2	54.3	62.0	16.5	19.5	l'edial over loamy,
20	Bwl	vfsl	5. 2	4. 4	37.7	45.8	17.0	14.1	ni xed
21	Ebl	vfsl	4. 8	4. 1	17.8	21.6	18.7	7.1	Typic Cryohunod,
22	Bhsb	sil	4.8	4. 0	38.1	67.9	31.5	26.2	Thi xotropi c-
23	Eb2	sil	4.8	4. 2	54.9	60.4	20.2	25.6	skeletal, mixed
24	2Bhsb	vgsi l	5. 0	4. 2	56.6	78.1	16.4	21.3	
25	Bsl	sil	5. 9	4. 9	30.7	30.5	31.7	14.8	Oxic Dystrandept
26	ВС	sil	6. 2	5.3	32.4	30.1	22.2	12.7	Medial, mixed,
27	A'	sil	6. 4	5.3	41.5	44.0	36.1	19.2	frigid
28	Bs2	sil	6. 4	5. 2	33.8	36.9	30.1	16.3	

From Chico-Lo Ping, Assistant Professor, University of Alaska, Agricultural Experiment Station, Palmer, Alaska, 78

TABLE 2. CEC DETERMINATIONS OF SOME ALASKAN SOILS FORMED IN LOESS

Sampl e	Soil	Texture	pH 1:1 CaCl	Cation NH <sub>4</sub> NA	Na∩Ac	hange Car BaC12	W cl	
Number	hori zon	class	H <sub>2</sub> 0 .01M	Cmol	(+)kg <sup>-1</sup>	(meq100g	m )	Classification
1	E	sil	4.4 3.6	27.7	22.7	20.5	10.0	Dystric Cryochrept
2	Bs	sil	5.3 4.4	10. 5	8.7	9. 5	16.5	Coarse-loamy/sandy
								or sandy-skeletal,
								mi xed.
3	A	sil	5.4 3.9	9. 4	8.3	7. 0	3.9	Pergelic Cryaquept
4	Вд	sil	5.2 4.1	6. 2	8. 9	6. 4	3.6	coarse-loany, nixe
5	A	sil	4.4 3.7	61. 7	71. 7	48. 2	28. 1	Pergelic Cryorthod
6	Bs	sil	5.3 4.5	44. 9	48. 3	43. 9	17. 0	Loamy-skeletal,
								mi xed
7	A	sil	6.0 5.3	31. 9	26. 7	24. 9	16. 2	Typic Cryorthent,
8	E	sil	5.9 5.2	22.5	20. 5	17.6	10.1	Coarse-silty over
9	Bw1	sil	6.4 5.5	14. 4	14.3	12.9	6. 9	sandy or sandy-
10	Bw3	sil	6.7 5.8	15. 2	16. 5	13. 9	8. 3	skeletal, mixed,
								aci d
11	A	sil	5.8 4.9	21. 0	2c. 2	17. 0	9. 0	Aquic Cryochrept,
12	E	sil	6.0 5.0	13. 3	13.8	12.3	5.9	coarse-silty over
13	Bw	sil	6.2 5.2	10.0	10. 2	10.4	5.4	sandy or sandy-
14	Bg	fsl	6.4 5.7	8. 6	6. 1	6. 7	4.8	skeletal, mixed,
								nonacid.
15	A	sil	6.5 5.7	19.1	12. 5	14.8	8. 9	Typic Cryochrept,
16	EB	sil	6.6 5.8	12.5	11.6	11.5	6. 2	Coarse-silty over
17	Bsl	sil	6.5 5.8	10.8	10.1	10.0	7. 3	sandy or sandy-
								skeletal, mixed
18	Bw1	sil	6. 1 5. 5	27.1	16.9	16. 9	13. 8	Alfic Cryochrept,
19	Eb	sil	6.6 6.1	14.2	12.1	12.7	10.4	Coarse-silty,
20	Btb	sicl	6.6 6.2	17.0	11.8	14. 4	13. 2	mi xed
21	A	sil	6.9 6.5	24.1	23.4	23. 5	21. 3	Typic Cryochrept,
22	Bw	sil	7.3 6.7	19.2	17.7	18. 2	17. 6	Coarse-silty over
								clayey, mixed

From Chien-Lu Ping, Assistant Professor, University of Alaska, Agricultural Experiment Station, Palmer, Alaska.

Table 2. Some properties of the soil samples.

Item	CEC-8.2 <b>(5A3a)</b>	CEC-7 <b>(5A6a)</b>	CEC <sub>NH4C1</sub> (5A9a)	ECEC (5A3b)	0.C. (5A1c)	Clay (3Ala)	CEC-8.2†	CEC-7t	CECNH4C1	
	——————————————————————————————————————	•	(3A)2) NH <sub>4</sub> )/kg			%	c4, 10			
Mean	13.8	9.3	7.3	4.8	1.11	43.8	34	23	18	12
Minimum	3.6	2.6	2.4	0.5	0.18	9.0	14	9	6	3
Maximum	38.1	27.8	31.9	15.3	5.89	66.X	<b>1</b> 21	75	71	67
Std. Dev	. 6.1	4.6	5.3	2.6	0.98	13.1	19	14	14	9

<sup>†</sup> Values calculated from the cation exchange capacities and clay contents for the samples.

Extracted from "Evaluation of Ammonium Chloride Retention as a Measure of Cation Exchange Capacity of Acid Soils" by W.D. Nettleton, J.M. Kimble, C.S. Holzhey, and R.E. Nelson.

Soil Conservation Service Midwest National Technical Center Federal Building, Room 345 100 Centennial Mall North Lincoln, NE 68508

# University of California Davis Soil Morphology Laboratory

<u>Table #2</u>

# Cation Exchange Capacity Comparison

	Sum of Cations						
	BaCl <sub>2</sub> - TEA	$BaCl_2 - TEA$	NH4OAC pH 7.0	+	Sum of Cations	Exchange	
	рН 8.2/Gyp.	pH 7.0/Gyp.		Exchange Acidity	(Ca,Mg,Na,K)	Acidity	
Sample			meg/100 g soi				
12-1	21.5	20.4	20.0	24.4	15.4	9.0	
12-1	21.5	20.4	20.3	24.2	15.2		
12-1	21.9	19.4	19.3	24.2	15.2		
12-l	21.5	19.4	19.4	24.4	15.4		
Avg.	21.6	19.8	19.75	24.3	15.3		
1298-2	14.1	12.7	13.3	16.5	8.4	8.1	
$\infty$ 1298-2	15.2	12.2	13.3	16.5	8.4		
1298-2	15.2	12.7	13.0	16.6	8.5		
1298-2	15.2	12.7	12.9	16.9	8.8		
Avg.	15.1	12.6	13.1	16.6	8.5		
1141-5	10.4	8.3	8.3	11.9	1.9	10.0	
1141-5	10.9	8.8	7.9	11.5	1.5		
1141-5	10.4	8.3	7.9	11.7	1.1		
1141-5	10.4	8.3	8.0	11.7	1.7		
Avg.	10.5	8.4	8.0	11.7	1.7		
1222-3	15.2	13.2	12.7	16.3	13.4	2.9	
1222-3	15.2	13.2	12.7	16.2	13.3		
1222-3	15.7	13.2	12.8	16.2	13.3		
1222-3	15.7	13.7	12.8	16.3	13.4		
Avg.	15.4	13.3	12.8	16.3	13.4		

		Sum of Cations							
	BaCl <sub>2</sub> - TEA pH 8.2/Gyp.	BaCl <sub>2</sub> - TEA pH 7.0/Gyp.	NH <sub>4</sub> OAC pH 7.0	+ Exchange Acidity	Sum of Cations (Ca,Mg,Na,K)	<ul><li>Exchange Acidity</li></ul>			
Sample			meg/100 g so			3			
1305-3	21.4	15.6	15.9	21.2	7.6	13.6			
1305-3	21.4	lb.2	15.6	21.4	7.8				
1 3 0 5 - 3	21.4	15.6	16.0	21.2	7.6				
1305-3	21.4	lb.2	15.0	21.4	7.8				
Avg.	21.4	15.9	15.6	21.3	7.7				
LS	18.9	17.4	18.0	21.32	19.6	1.7			
LS	18.9	17.4	18.4	21.32	19.6				
LS	18.9	17.9	la.4	21.4	19.7				
LS	18.4	17.9	18.2	21.5	19.8				
⇔ Avg. U	18.8	17.7	18.2	21.4	19.7				

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# University of California Davis Soil Morphology Laboratory

# Clay Pretreatment Study

<u>PURPOSE:</u> To determine the effect of various **pretreatment** procedures on particle size analysis; specifically clay percentage.

# MATERIALS AND METHODS:

- I) No Pretreatment 20.0 Grams of air dried soil (< 2mm) was mixed with 100 ml. of Sodium Hexametaphosphate in a shaker bottle and shaken for 15 hours at 90 R.P.M. Clay was sampled using the pipette method and reported on an oven dry basis.
- II)  $H_2O_2$  Pretreatment  $H_2O_2$  was added to the soil and the mixture placed on a steam bath. The  $H_2O_2$  was added in 10 ml. increments until effervescence ceased. The liquid was then candled and the soil washed twice with distilled water. The soil was then dispersed following the sodium hexametaphosphate and shaking procedure in I), above.
- III)  $H_2O_2$ , Oven Dry Pretreatment  $H_2O_2$  treatment was performed on the soil samples as in II, above. Following washing, the samples were placed in a drying oven at 105°C for 24 hours before being transferred to a shaker bottle. The remainder of the procedure followed I), above.
- IV)  $H_2O_2$ , Freeze Dry Pretreatment  $H_2O_2$  treatment was performed on the soil samples as in II), above, Following washing, the samples were freeze dried for 24 hours before being transferred to a shaker bottle. The remainder of the procedure followed I), above.

COMMENTS: For comparative purposes clay percentage was calculated on an oven dry basis using air dry moisture values. However, following freeze drying the samples were weighed prior to particle size analysis to obtain actual dry weight on a mineral basis. The clay percentage values calculated using actual dry weight are listed beside the column calculated using the air dry moisture correction and O.M. correction.

It is assumed that no soil was lost during the  $\rm H_2O_2$  treatment and transfers in methods II), III), and IV).

Values reported on a mineral basis resulted from subtracting the organic matter weight from the sample weight. Organic matter weight was assumed to be equal to  $1.73~\chi$  O.C.

RESULTS: Results are listed in Table #1. Each value represents the mean of four trials, unless otherwise stated. Organic carbon values, determined by the induction furnace method, are presented in addition to the percent clay data.

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Table #1

Clay Percentage Values

# I % Clay Whole Soil Basis

Sample	Control	H <sub>2</sub> O <sub>2</sub> N.D. <u>Treatmen</u> t:	Н <sub>2</sub> 0 <sub>2</sub> О. D.	ዚ <b>202</b> F.D.	% O.C.
	I	ΙΙ	III	IV	
1) 1566-2	48.73	48,94	46.59	48.47	0.20
2) 1566-1	33.54	33.92*	30.75	33.62*	0.23
3) 1552-2	31.21	31.77	31.66	31.45	0.26
4) 1553-l	28.25	28.64	28.51	28.62	0.43
5) 1547-2	46.95*	48.51	48.91"	49.53	0.33
6) 1522-1	32.45	33.35	33.65	33.21	0.38
7) 1565-l	45.53	45.52	44.66	45,13*	0.42
8) L.S.	13.08	13.57	12.96	12.03	0.51
9) 1515-2	31.25	31.55	31.50	31.89*	2.07
10) 1525-1	6.09†	6.24	6.431	5.85	5.00
II % Clay Min	eral Basis				
	I	ΙΙ	III	IV <sup>A</sup> /	IVB/
1) 1566-2	48.90	49.10	46.68	47.86	48.64
2) 1566-1	33.67	34.05*	30.74	33.32"	32.15*
3) 1552-2	31.35	31.91	31.77	31.48	31.59
4)					
5) 1547-2	47.21*	48.19	48.82*	48.73	49.81
6) 1552-1	32.67	33.56	33.85	33.36	33.42
7) 1565-1	45.86	45.86	44.91	44.48*	45.46*
8) L.S.	13.18	13.62	13.63	12.10	12.13
9) 1515-2	32.35	32.72	32.43	31.92*	33.07*
		0.00	7 001		

10) 1515-1

6.66+

6.83

7.08+

6.83

6.41

<sup>\*</sup> = mean of 3 trails

t = mean of 2 trials

A/ = Actual dry weights

B/ = Calculated dry weights

# Lithic Paralithic Study Report by William R. Allardice

# Introduction

Dr. Arnold's remarks yesterday concerning perfecting the definitions in Soil Taxonomy were appropriate; in the spirit of clarifying the definitions of lithic and paralithic contacts The California Soil Survey Committee challenged the existing criteria (1976).

# History

The Concept of Lithic and Paralithic material is illustrated in "Guy D. Smith Discusses Soil Taxonomy" p. 30 - Reprints from Soil Survey Horizons.

According to Guy Smith, if the material had to be blasted it was Lithir if it could be dug with heavy equipment it was paralithic. Those concepts were translated into field criteria as follows:

"The underlying material must be sufficiently coherent when moist Lo make hand digging with a spade impractical." Paralithic

"When moist, the material can be dug with difficulty with a spade.  $^{\text{II}}$ 

Hardness, cracks and roots are part of the current definition of lithic or paralithic materials. Difficulty in consistent application of the criteria generated several studies in search of an improved definition of the criteria.

## Conflict

Soil scientists from North Carolina and Virginia (1975) recognized the importance of Consistent identification of Saprolite vs. paralithic material.

A year later field studies were conducted in Nebraska and South Dakota because of the "lack of uniform recognition of paralithir contacts...". Conclusions from their study were "...(la) either the definition of paralithic contacts be amended or (lb) that the rule of application be devised to adjust the application of the definition".

At the same time scientists in California were struggling with similar problems. California's problem centered around the requirement that cracks be at least 10 cm apart. The California Soil Survey Committee charged the Soil Classification Subcommittee with the responsibility of refining the definitions of lithic and paralithic contacts so that consistent identification of the contacts would occur. As a part of their investigation a field conference was held in Shasta County, California in 1976.

### Review and Research

The field conference examined 14 sites, 10 lithic contacts, 5 paralithic contacts and 3 probable paralithic contacts. The current criteria were used in the selection of the sites. The sites were sampled and materials returned to the laboratory for evaluation.

Gravel size fragments were cut into 2 cm cubes and placed into 8 oz shaker bottles 3/4 filled with distilled water. The samples were allowed to stand for 15 hrs then placed on a horizontal shaker for an

additional 15 hrs of shaking at 90, 120 and 150 cpm. % dispersion was based on a visual estimate of the remaining material.

### Results

Six lithic and six paralithic materials were tested at 90 CPM only two of the paralithics dispersed -40% and -95%. 4 paralithics and the 6 lithics remained undispersed. At 120 CPM 8 samples were tested, two paralithics dispersed and 1 lithic was 20% dispersed. Seven samples were tested at 150 CPM two lithic materials dispersed to -85% and -95% the remaining samples were less than 10% dispersed (2 lithics and 3 paralithics).

# Proposed Resolution

As a result of the field conference and lab data, several revisions were proposed to clarify the definition of lithic and paralithic contacts by the CSSC. The original words are lined out with dashes and the proposed wording is underlined (refer to your handouts). Briefly the changes are as follows:

# General Lithic and Paralithic

- 1. The term fractures replaces the term cracks
- 2. Spacing requirements between fractures should be changed as follows:
  - a) to contacts with no fractures or with fractures no closer than 30 cm measured horizontally in any direction and extending downward at least 25 cm ... The term hololithic or holoparalithic would be applied.
  - b) to contacts with fractures closer than 30 cm measured in the same manner ...the term . . . fractolithic or fractoparalithic would be applied.
- 3. The term recognizable angular displacement by natural means replaces significant displacement.

In addition to the general changes to the definitions there are specific changes:

- 4. To lithic contacts
  - a) add a section "or pieces can be levered out of position where sets of fractures exist"
  - b) establish limits of dispersion. Dispersion must not exceed any of the following estimates:
    - 1) 10% at 90 CPM 15 hr
    - 2) 50% at 120 CPM 15 hr
    - 3) 95% at 150 CPM 15 hr
- 5. Paralithic contacts have an ambiguous term "more or less completely dispersed" we need to say what is intended, i.e., more than 10% dispersion indicates the **presence of a paralithic.**
- 6. Fragmental and skeletal have been revised to complete the handling of contacts and related materials.

Fragmental add "including angularly displaced rock fragments related to immediately underlying lithic or paralithic materials" [as well as delete fine earth and add "coarse sand or finer particle-size". ]

Skeletal: Sandy, loamy and clayey add "including angularly displaced rock fragments related to immediately underlying lithic or paralithic materials".

### Conclusion

The California Soil Survey Committee has proposed new definitions that will result in more consistent interpretation of lithic and paralithic contacts. While their proposal was rejected in 1977 they currently plant to meet on June 4-7, 1984 to review the status of their project and continue (in the spirit spoken of by Dr. Arnold) their efforts to improve this segment of Soil Taxonomy.

There remains the problem of correlation between field criteria and a standard repeatable laboratory determination and such questions as what is a paralithic that fails to disperse or how do you handle a lithic that does disperse?

#### References

- 1. Soil Taxonomy
- 2. SCS Communication Oct. 2, 1975; Saprotite and Paralithic Contact Study

  North Carolina and Virginia Sep. 2, 1975; Dr. John Witty and F. Ted Mitter
- 3. SCS Communication Mar. 31, 1976; Field Study Trip Paralithic Contacts and Underlying Material in Nebraska and South Dakota, Nov. 3-7, 1975; Maurice Stout Jr.
- 4. SCS Communication May 25, 1976; MGT Trip Report Lithic Paralithic Trinity Co. . . .
- 5. Calif. Soil Survey Committee Soil Classification Subcommittee

  Lithir Paralithic Fragmental Skeletal Study Shasta Co. California

  Oct. 20-22, 1976
- 6. SCS Communication Sept. 28, 1977; Soil Taxonomy Lithic Paralithic Contacts

  John E. McClelland
- 7. Guy D. Smith Discusses Soil Taxonomy; Reprints from Soil Survey Horizons

•	Proposed revision of Lithic Contact definition (pg. 48, Soil Taxonomy)
	Lithic Contact
	A lithic contact is a boundary between soil and coherent underlying
	material. Except in Ruptic-Lithic subgroups. or in lower categories
	$\underline{with\ similar\ contact\ interface\ configurations\ within\ 1\ m\ depth},\ the$
	underlying material must be continuous within the limits of a pedon
	except for eracks fractures produced in place without significant
	recognizable angular displacement of the pieces by natural means.
	Cracks-should-be-few,-and-their-
	·
•	

such as a duripan or a petrocalcic horizon. A lithic contact is diagnostic-ot-the-subgroup-level-if-ft-is-within-50-cm-of-the---

There are two kinds of lithic contacts. Those with no fractures, or with <u>fractures extending downward at least 25 cm</u>, but no closer together than 30 cm (measured horizontally in any direction within a <u>pedon</u>), are termed hololithic contacts. These with similar fractures closer together than 30 cm measured in the same manner, but excluding inter-mineral microjointing, are termed <u>fractolithic</u> contacts.

Either kind is diagnostic at the subgroup level as a lithic contact if within 50 cm of the surface of a mineral soil. They are separately diagnostic at the series level if located within the control section of the series.

2

Proposed revision of the Paralithic Contact definition (pg. 49. Soil Taxonomy

## Paralithic Contact

A paralithic (lithic-like) contact is a boundary between soil and continuous coherent underlying material that is continuous within the limits of a pedon except for fractures produced in place without recognizable angular displacement of resultant fragments by natural means. It is similar in configuration, but differs from a lithic contact in that the underlying material, if a single mineral, has a hardness by Mohs scale of less than 3. If the underlying material is not a single mineral, chunks-of gravel size fragments that can be broken out disperse more or less completely during 15 hours of end ower-end horizontal shaking in water or-in-sodium-hexametephosphate solution in the same manner described in the definition of a lithic end When moist, the material can be dug with difficulty with contact. a space. The material underlying a paralithic contact is-normally a consists of partly consolidated sedimentary rock, or other bedrock weathered to a depth of at least 25 cm below the contact. Its bulk density or consolidation is such that roots cannot enter. There-may be - eracks - in-the - rocks -- but -- the - horizontal -- spacing - between -- eracks should-be-10-em-or-more.

There are two kinds of paralithic contacts. Those with no fractures, or with fractures extending downward at least 25 cm, but no closer together than 30 cm (measured horizontally in any direction within a pedon), are termed holoparalithic contacts. Those with similar

fractures closer than 30 cm measured in the same manner, but excluding inter-mineral microjointing, are termed fractoparalithic contacts.

Either kind is diagnostic as a paralithic contact at the family level, and in some subgroups, if within 50 cm of the surface of a mineral soil. They are separately diagnostic at the series level if located within the control section of the series.

Proposed revisions of those particle-size class definitions relevant to lithic or paralithic contacts (pgs. 383, 384, Soil Taxonomy)

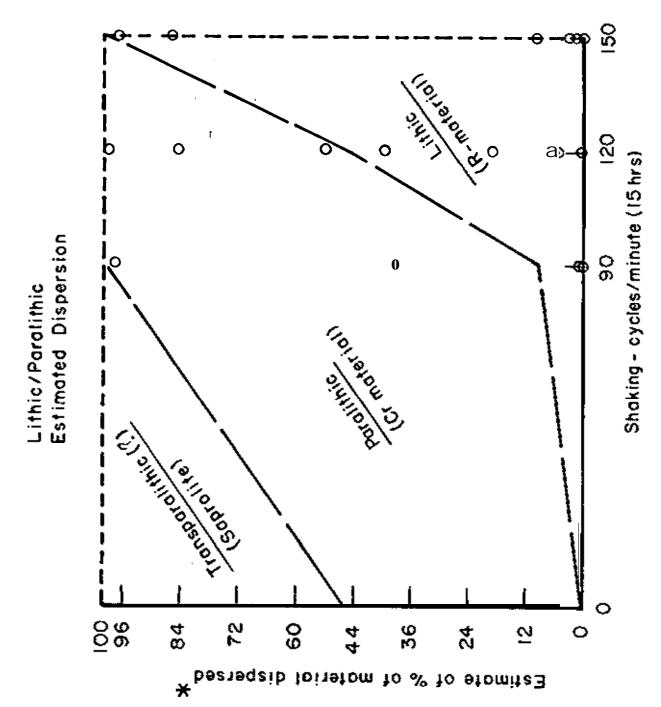
Fragmental - Stones, cobbles and gravel, including displaced rock fragments related to immediately underlying lithic or paralithic materials, as well as and very coarse sand particles; too little fine earth coarse sand or finer particle-sizes to fill some of the interstices larger than 1 mm in diameter.

Sandy-skeletal - Rock fragments 2 mm in diameter or larger, <u>including</u> displaced rock fragments related to immediately underlying lithic or <u>paralithic materials</u>, make up 35 percent or more by volume; enough fine earth to fill <u>all</u> interstices larger than 1 mm; the fraction finer than 2 mm is sandy as defined for sandy particle-size class.

Loamy-Skeletal - Rock fragments, <u>including angularly displaced</u> fragments related to <u>immediately underlying lithic or paralithic</u> materials, make up 35 percent or more by volume; enough fine earth to fill all interstices larger than 1 mm; the fraction finer than 2 mm is loamy as defined for the loamy particle-size class.

Clayey-skeletal - Rock fragments, <u>including angularly displaced</u> fragments related to <u>immediately underlying lithic or paralithic</u> materials, make up 35 percent or more by volume; enough fine earth to fill all interstices larger than 1 mm; the fraction finer than 2 mm is clayey as defined for the clayey particle-size class.

150 95 82 cpm Shaking <u>8</u> 20 06 Ily Estimoted % Sample L-1-2B L-2-7A L-2-6 L-2-5 ē 50 N



Percent dispersion of 2 x 2 x 2 cm samples determined by visual estimate

# committee 3: Soil Rating Criteria for Off-Road Vehicles

Chairman: John Key, Bureau of Land Management

Fed. Bldg. Rm. 311 800 Truxtun Ave.

Bakersfield, CA 93301

Tom Ryan (FS)

Jim Ponerening (Cal Poly - Pomona) Jack Rogers (SCS-MT)

Henry Waugh (BIA-NM)

0. Harja (COE)

M. Rollins (BLM-MT)

R. Tarlock (Cal Poly - Pomona)

L. Langan (WNTC) M. Swiger (UCD)

Harry Summerfield (FS - Nevada)

S. Fisher (BLM)

Harold Maxwell (SCS-ID)

Hayden Rounsaville (USFS-Colo - Reg. 2)

William Crane (BLM-Colo)

### Charges:

- (1) Distribute the proposed guide to members of other Regions of the National Cooperative Soil Survey for field testing and review.
- (2) Evaluate review comments and field testing of the proposed guide to soil rating criteria for ORV's.
- (3) Report consolidated comments on the proposed guide to Committee 5 Chairman and 1984 Steering Committee by January 15, 1983.

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Guide for Rating Soil Limitations for Wheeled Off-Road Vehicles (Proposed by Committee 3. Western Regional Soil Survey Work-Planning Conference, February 1982)

Revised Ma 1983 MAT. Limits Soil Property or Quality Slight Moderate Restrictive Feature Severe Water Erosion Hazard A' = (KSR) for T of: a. 0.5 t./ac./yr.0.5 t./ac./vr.0.5 t/ac./vr 0.5-1.0T./ac./yr.b. lt/ac/yr 1 t/ac/ve 1-2 t/ac/yr 2 t/ac/yr Erodes easily 2-4 t/ac/yr 4 t/ac/yr c. 2 tlaclyr 2 t/ac/vr 6 t/ac/yr d. 3 t/ac/vr 3 tlaclyr 3-6 t/ac/vre. f. 45 t/ac/vr 4 5 tlaclvr 10 8 tlaclvr 5-10 4-8 t/ac/vr t/ac/yr t/ac/yr t/ac/yr t/ac/yr Wind Erosion Hazard 1/ 6.7.8 Soil blowing 3.4.4L.5 Wind erosion group of 1.2 surface layer Soil compaction 2/ Unified class ML.CL.OL.MH.CH GW.GP.GM.GC.GW-GM. SW.SP.SM.SC OH. CL-ML.PT GW-GC .GP-GM GM-GC.GP-GC. SM-SC. SW-SM, SW-SC

SP-SM.SP-SC

<sup>1/</sup> Applicable only at time periods when the surface of the soil is dry and the wind velocity is greater than 8 miles per hour at 6 inches above the ground, or 13 miles per hour at 1 foot above the ground.

<sup>2/</sup> The soil compaction ratings in this guide are for the moist and wet soil-moisture states. The compaction of most coherent soils is greater for the moist and wet moisture states than for the dry state.

# COMMITTEE 3 - SOUTHERN AND WESTERN REGIONAL WORK-PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY - MAY 1984

# OFF ROAD VEHICLE RATING GUIDE

Guide for Rating

Narrati ve

Summary Evaluation

Example of Applied Criteria in the California Desert

# Proposed Revised Guide for Rating Soil Limitations for Wheeled Off-Road Recreational Vehicles (Proposed by Committee 3, WRTSSWPC, February 1982)

Note to reviewers: This is a draft of the narrative to accompany the Guide.

Wheeled off-road vehicles include motorcycles, minibikes, trail bikes, dune buggies, and all-terrain vehicles. They do not include snowmobiles. This Guide is for rating the degree of soil limitations for use by recreational vehicles only when they are crossing the terrain in a repeated manner causing trails to become barren of vegetation. It is not applicable for planning and designing master intensive ORV use-areas, such as hillclimb areas, because that kind of activity invariably results in an irreparable reduction in soil productivity, which will require special on-the-site investigation.

Off-road vehicles can lower the natural productivity of the soils by increasing the amount of erosion and by compacting the soil. the soil limitation ratings are based on the water erosion hazard, the wind erosion hazard. and soil compaction. The water erosion hazard rating is based on the soil erodibility (K) factor, the slope gradient (S) factor, and the rainfall (R) factor of the Universal Soil Loss Equation (USLE). The vegetative cover (C) factor is given a value of 1.0 because the continued use of an area by the vehicles generally results in the formation of unvegetated trails in which the surface layer of the soils is disturbed. The wind erosion hazard rating is based on the standard wind erosion groups. The wind erosion hazard is only applied when the uppermost layer of the soil is dry and the velocity of the wind is equal to, or greater than, the threshold velocity for sand grains of 0.1 mm in diameter. The soil compaction rating is based on the Unified engineering soil classification groups of the surface horizon. The soil compaction ratings in this Guide are for the moist and vet moisture states. The compaction of most coherent soils is greater for the moist and vet states then for the dry moisture state.

Therefore, we suggest rewording lines 4 and 5 of paragraph 1 as follows: -- "recreational vehicles only when they are crossing the terrain in a repeated manner causing trails to become barren of vegetation.

Chairman's Comments to the Committee Members and Other Reviewers of the Proposed Guide for Rating Soil Limitations for Dee by Wheeled Off-Road Recreational Vehicles

The latest edition of the Guide constitutes a minor revision of the Committee's recommendation and is intended as a "flyer" for review and com-The only changes from the Guide circulated for review are the additions of 0.5 T A/yr. under water erosion hazard (MUSLE) (to accommodate nonrenewable soils), and the wording "soil compaction" in lieu of "soil strength." Both compactive effort and soil moisture state have such over riding influences on "soil strength" that use of the term does not correlate well with soil class and may confuse rather than clarify the meaning On the one hand, we are using the term to evaluate the impacts upon plant growth and on the other hand we are using it to evaluate bearing capacity from an engineering veiwpoint. Dave McNabb, Extension Watershed Specialist for the Oregon State University Forestry Intensified Research Program (FIR), has studied the impacts of tractor logging on Southwest Oregon soils (unpublished). (Note: Tractors can be considered off-road vehicles.) He has concluded that soil strength increases with increase in compactive effort and that some soils are moisture insensitive (MI) and some soils moisture sensitive (MS) to compaction at low compactive efforts. Also, that logging vehicles impart low compactive efforts to soils. The number of passes by ORVs is equivalent to compactive effort. That is, the greater number of passes the greater the compactive effort. A low number of passes would correlate with low compactive efforts. This has been shown by studies in the California Desert (BIM - California State Office).

I have incorporated Charles **B. McElroy's** recommendation to substitute "soil compaction" for "soil strength" as a criterion for rating soil limitations. I realize that this is a minority recommendation but it is forthcoming from an expertise quite knowledgeable in soil engineering interpretations.

Clifton Deal. Soil Mechanic Engineer from SCS WNTC Portland, Oregon, has suggested the addition Of Soil Trafficability to the criteria for rating soil limitations. Perhaps the addition of Soil Trafficability is worthy of Committee consideration. Properties or qualities to be considered are those such as slope gradient; surface rock fragments; surface rock outcrops; puddling potential, wet (using R values); depth to the wet state at time of use or drainage class; flooding. The Soil Trafficability addition would then allow for deletion of the present Guide for Rating Soil Limitations for Off-Road Trails, NSH, Part II, Section 403.6 (b), USDA SCS, 1979, which is primarily a Soil Trafficability Guide for ORV Trails. Pomerening's first approximation of the Guide contained Soil Trafficability criteria as well a\* soil wetness criteria. If the Committee members are in favor, these could be incorporated into the Guide, with little effort.

Some minor changes suggested by the reviewers have been made in the wording of the narrative preceding the Guide.

comes from Forest Soil Scientists who are concerned because the criteria rate most forestland as severely limited for off-road vehicle (ORV) use primarily because slope gradients usually exceed 10% on forestland, assigned slope lengths are different, C factor differs and R factors are higher. Also, the problems seem to be gully erosion instead of sheet or rill erosion on forestland. However, gully erosion normally begins as sheet or rill erosion. Moreover, these criteria are not intended for application to hill climbs as stated in the narrative portion of the Guide. The R factor used should be determined from the beat available local rainfall data and runoff data for areas receiving significant amounts of snowfall, not from regional R factor maps. The C factor has been adequately addressed by Dissmeyer and Foster.

Eight responses recommended the need for additional properties, qualities, or other criteria. These included fragility, slope, permeability, flooding, sodium absorption ratio (SAR), exchangeable sodium percentage (ESP), energy imparted to the soil (compactive effort), soil displacement, puddling potential, drainage class, soil trafficability, soil moisture regime, dustiness, percentage of surface coarse fragments, workability, and visual effects.

### **Specific Remarks From Reviewers**

#### 1. On USLE

- a. A major factor in the USLE may prove to be identifying soil loss tolerance (T) factors for rangeland soils.
- b. Realistic T factors may prove to be critical if the USLE is to be used in evaluating ORV areas.
- c. We strongly feel that the USLE. or its modification, MUSLE, should not be used to evaluate water erosion hazard because USLE estimates sheet erosion and most of the erosion caused by ORVs will be gully erosion.
- d. Referring to soil loss on a "per acre" basis could be misleading if the actual loss is confined to the specific ORV trails which represent very small acreages.
- e. The cover factor of 1.0 is too high. A cover factor of 0.72 or 0.85 for bareland from Table 4 titled C Factors for Mechanically Prepared Woodland Sites (Procedures for Computing Sheet and Rill Erosion On Project Areas, Technical Release No. 51 (Rev. 2), SCS, 1977., p. 11) would be more appropriate.
- f. I do not feel a nationwide guide would be futile. Suggest a correlation framework using soil moisture and temperature regimes to accomplish this end.
- g. The slope length of 72.6 feet is too high for nonagricultural land. A slope length of 10 or 20 feet would give a more accurate slope length factor on forestland or rangeland.

- h. Certain vegetative types contribute sufficient litter to change the USLE cover factor.
- Perhaps the C factor should be a variable that would be a constant within fixed slope classes (i.e., a value of 1.0 for slopes less than ax, a value of 1.5 for slopes between 9 and 15%, and a value of 2.0 for slopes greater than 15%). By varying this value, at least we are indicating that cover has an impact on erosion and its impact increases as the slope increases.
- j. The A factor depends on several variables that are not intrinsic to individual soil series, The limitations should be detailed enough to address these factors more directly.
- k. The T values used may allow excessive soil losses for many western arid soils which are nonrenewable. Therefore, a set of criteria is needed for determining renewable vs. nonrenewable soils; (e.g., precipitation, hardness of bedrock, contents of salts, and agricultural vs. nonagricultural potential). New Mexico has assigned separate T designations for different soil depths for both renewable and nonrenewable soils.
- 1. For evaluated sites the proposed rating criteria seem to substantially underpredict soil losses.
- m. It seems to us that the soil factors that determine a soil resistance, or susceptibility to gullying, should be considered rather than the USLE.
- n. During the testing period, it is hoped that measurements will be made to evaluate the effect of compaction on the erodibility of the soil (i.e., the effect on the K factor).
- o. I believe the **K** factors for estimating water erodibility should be modified by the influence of exchangeable sodium content.

# 2. On Wind Erodibility Groups (WEGs)

- a. The use of **WEGs** alone for the wind erosion potential seems oversimplified. Topography, surface roughness, vegetation and rock fragment **content can** all affect the wind erosion potential.
- b. I find placing soils into Wind Erodibility Groups difficult using the table supplied by the SCS. Not all textural classes are covered by the table (i.e., sand and loamy coarse sand). No guidance is given to the effects of rock fragment content, erosion pavements, rock out crop, slope and slope complexes.
- c. The wind erosion hazard criteria appear to be incomplete. The draft criteria are comparable to using the K value for water erosion hazard. I would recommend as criteria either the number of days soil blowing exceeds a given value or criteria analogous to the water erosion hazard criteria (i.e., A = ickl for T of;).

d. Soil blowing does not adequately convey the meaning I like. Perhaps blows easily or erodes easily wind would be approved.

#### 3. On Soil Strength

- I strongly disagree with the third soil property or quality, "soil strength," used in this Quide. The background data refers to the use of bearing capacity, CBR and R values for the various Unified Soil Classes. One cannot use the numbers quoted unless the area of load applied is specified. The developers of this Guide are trying to make the problem of soil compaction a soil strength problem. Why not call this property "Soil Compaction"? all, this is what we are concerned with here. In a moist state. the tires of the off-road vehicles will compact the soil into a dense state which makes it more difficult to establish or maintain vegetation. I have shown proposed changes, in red, on the attached pages 6, 7, 8, 9, 10 and 11. Note that if the property is changed to "Soil Compaction," only one minor change is recommended in the "Limits" plus a change in the "Restrictive Feature." have incorporated this proposal by Charles B. McElroy, Head of the Soil Mechanics Lab, SCS SNTC, Ft. Worth, Texas, in a revised set of proposed guidelines for review).
- b. The use of soil strength as a rating criterion seems inappropriate for this Guide. Strongly suggest something like "Soil Trafficability" be used. This will convey the soil property or quality that is really involved when evaluating a soils limitation to wheeled off-road vehicle use. Soil strength can be interpreted to represent many other things than desired and is only very roughly represented by soil class. The major concern seems to be whether the soil will, under moisture ranges from moist to wet, support the expected wheel loads and use. This involves many other soil characteristics than soil strength. such as, consistency, pumping (punching shear resistance), capillarity, and workability. All of these items are more readily related to soil class. (Note: Comments from Clifton E. Deal, Soil Mechanics Engineer, SCS WNTC, Port land, Oregon. I have addressed these in the Comments of Chair man to Committee Members and Reviewers).
- c. Soil strength is a good factor and the class limits appear satisfactory.
- d. The proposed Guide appears to have a limited usefulness in areas where the sequence of soil moisture states is not the same for every soil. I do not believe it would adequately segregate soils in humid areas. Perhaps the rating should consider both soil strength and soil moisture regimes.
- e. Because of time and cost involved in obtaining laboratory data for some parameters, field oriented procedures would be preferred for soil strength criteria.

- f. Pomerening mentions the absence of soil drainage class criteria (p. 10, under Discussions of Comments...) but does not explain why none were included for depth to water table or soil drainage class. Three concerns related to soil strength and disturbance are displacement, compaction, and puddling. It is impossible to represent all three concerns by the same scale of Unified Classes. For example:
  - (1) Soils in the CH class are among the most easily puddled when wet, but among the **most** resistant to displacement when dry.
  - (2) Soils in classes SP and GP are among the most easily displaced when dry, but among the most resistant to compaction when wet and practically immune from puddling. Soils in these classes have greater strength moist than dry.
  - (3) Soils in classes SC and GC are some of the most readily compacted when moist, but are intermediate in susceptibility to displacement and puddling.

In conclusion, soils with **Aridic, Ustic,** and **Xeric** moisture regimes should be rated for soil strength under dry conditions, as well as under moist conditions, and very poorly drained soils should be rated for soil strength under vet conditions. Slope gradient is a factor in soil displacement, particularly under dry conditions when the soil can be thrown farther by spinning wheels.

# 4. Overall Rating

- a. The proposed ratings are not tied to use parameters that can be manipulated by a land manager such as:
  - (1) Amount of use that can be accepted in terms of number of vehicles, kind of vehicles, and frequency of use.
  - (2) Timing of use, as season of year and intervals between uses.
- b. It took several times longer to rate soils using this proposal than using the 1978 system.
- c. This new system makes it all but impossible to rate any soil "slight." (Rote: In Coachella Valley, California, 22% of the soils rated as having only slight limitations for use by wheeled ORVs.)
- d. The case built by the **Committee** seems strong and well worth testing; once adequate testing is done, the Committee should then make appropriate recommendations.
- e. Random travel on Montana landscapes will not result in the removal of vegetation. Therefore, the C factor will not be 1.0. But repeated use of trails by **ORVs** will cause vegetation to be lost.

Summary Evaluation and Review of Response to Field Testing of Proposel Guide to Rating Soil Limitations for Off-Road Vehicles

Results of the review of the 1982 Western Regional Technical Soil Survey Work Planning Conference (WRTSSWPC) Proposal I (44 responses) I concur:

1. With the proposed Modified Universal Soil Loss Equation (MUSLE) concept for evaluating the water erodibility hazard:

'Yea 305 9

2. With the proposed A value limits:

Yea 28 No 16

3. With the proposed concept for evaluating the wind erodibility hazard:

Ye8 37 No <u>6</u>

4. With the proposed wind erosion hazard limits:

Yer 36 No <u>7</u>

5. With the use of soil strength es a rating criterion:

Yes 40 No 3

6. With the proposed concept of using the Unified Classification for evaluating roil strength:

Yes 40 No 3

7. With the proposed soil strength limits for alight, moderate and severe:

Yes 39 No 4

(Write-in)

8. Need for additional properties, qualities, or other criteria:

Yes 8 No 2 No comment 34

#### **General Reactions From Reviewers**

The two most controversial, or debatable, criteria appear to be the A value limits and the need for additional properties, qualities, or other criteria. The debate centering around the A value directly involves disagreement with acceptance of the Determinant of Soil Loss Tolerance or T value. This is readily understandable because the estimated time frame for the development of one inch of a horizon differs among soil taxa. Eight of those responding felt that additional properties or qualities are needed. Much of the reservation expressed about the proposed criteria

#### SOIL LIMITATIONS AND RATINGS FOR ORV MHEELED VENICLES USING COMMITTEE 3 WATSSWPC CRITERIA

			MAT ERO	ER SEON			IND ROSION	SOIL STREN	त्रम	OVERAL RATING	
atı	¥	Ŧ	SZ S	A'	Reting	MEC.	Rating	Unified Class	Auting	Cale	Windy
Mohave 1s, O to 12 slopes	0.28	2	I.	0.81	Slight Slight	2	Zevere	SM	Moderate	Slight to Hoderate	Severe
Cajon Sand. 2 to 9% slopes	0.15	2 5	6	2.13	Moderate Slight	1	Severe	SM SP-SM	Moderate	Moderate	Severe
Arizo vgCos, 2 to 92 <i>Slopes</i>	0.10	2 5	6	1.42	Slight Slight	5	Moderate	GP	Slight	Slight	Moderate
Arizo vgS, 0 to 22 slopes	0.10	2 5	1	0.29	Slight Slight	5	Moderate	CP	Slight	Slight	Hoderate
Typic Camborthid S.S., mixed thermic 2 to 3% slopes(Er.Pay)	0.10		3	0.64	Slight Slight	8/5	Slight Moderate	GP/ML	S11ght Severe	Slight	<u>Slight</u> Moderate
Arenic Haplargide S.S., mixed, th., 2 to 3% slope S. (Er. Pav)		<b>2</b> 5	3	0.64	Slight Slight	1	Severe	SP.SW	Moderate	Slight to Moderate	Severe
O Hohave loam, 0 to 22 slope, Clayey	0.63	2 5	1	1.	Slight Slight	5	Moderate	HL or CL	Severe	Moderate	Hoderate
O Typic Camborthid 1 Co.1., mixed, Th 0 to 12 slopes	<del>0.32</del>	5	ī	0.93	Slight Slight	-5	Moderate	HL,	Severe	Hoderate	Hoderate
2 Cajon 1.s., 2 to 15% slopes	0.15	2 5	8	3.15	Severe Slight	2	Severe	SH	Moderate	Hoderate to Severe	Severe
3 Typic Torri orthends, s/1, sixed, thermic 0 to 12 miopes	0.15		1	0.46	Slight Slight	1	Severe	SM SP-SM	Moderate	Siight to Noderste	Severe

0

		!	. E. K.	WATER EROSTON		HIND EROSION	10k		SOLL STRENGTR	OVE RAT	OVERALI. Rating
SOLL	× !<		S. He	hedia! A	Rating	uan	Rating	Und fised Class	Ration	Calm	Vinde
Saline, O to 12 alopes	9:00   1:00    -	0, 24 0, 24	S11ght S11ght	-	Severe	NS-4S	] 	Silght	Severe		
#15 Wohave fe. #16 1 to 2% #lopes	0.13	~ ~	~	0.68	Sitght	  -	Severe	NS-48	Haderate	Moderate Slight to	Severe
/ Cajon gs, 2 to 4; slopes	0.10	. s	_	0.46	Slight Slight	<u></u>	Hoderate	#5-55 KS		Moderate Slight	Moderate
in Mohave Ry, O to 17 slopes	0.15	~~	-	97'0	S11ghr S11ghr	  -	Severe	HS-45	Modernie	Hoderate Stight	Severe
120 2 to 42 Slopes	0.15	5	١	0,97	S11ght S1fght	-	Severe	98 - SP	Hederate	Moderate Slight to	Severe
			j							Moderate	

Committee

# REPORT OF COMMITTEE FOUR EDUCATIONAL REQUIREMENTS TO MEET FUTURE NCSS NEEDS June 28. 1984

#### Charges And Recommendations:

- Charge 1: Develop An Idealized Curriculum in Soil Science (Starting with the Southern Regional Conference Curriculum)
  - Recommendation: The Committee will recommend a prioritized course curricula list for Soil Science, based on results of the questionnaire distributed at the 1984 El Paso meeting.
- Charge 2: Work With the Office of Personnel Management to Make Their Soil Science Evaluation Criteria Known to the Universities. Advise the Office of Personnel Management Regarding Adequacy of the Criteria

#### Recommendations:

- 1. Recommend that OPM consider the prioritized course list curriculum as a supplement to its current rating criteria.
- 2. Recommend to OPM and universities that coursework in personnel management and/or public relations be part of the curriculum in Soil Science.
- 3. Recommend to National Soils Technical Work-Planning Committee that the OPM rating system for entry level soil scientists be made public.
- Charge 3: Assess Multiple Agency Soils Training Needs and Methods.

  Propose Agency-University Mutually **Beneficial** Cost Shared **Training** Programs.

#### Recommendations:

- 1. We identified a need for training in computerized data processing. The committee recommends investigating university extension and cooperative education programs for application to NCSS training needs.
- The committee identified a need for SCS-type training for agency soil scientists. The committee recommends reminding agency heads that the SCS can usually provide training If requested. Policies of Interagency cooperation should be documented and publicized.
- 3. The committee recommended that soil scientists need practical experience with soils information users. The committee recommends contacting administrative heads of agencies to encourage short-term practical experiences for soil scientists via temporary reassignment or Inter-agency personnel exchange.

- Charge 4. Assess Training Needs for State or Regional Level Agency Soils Staff
  - 1. Solution Propose more joint agency-university research projects centered around areas of research excellence. Have agencies identify research needs and contribute funding (for graduate students?) and personnel to do field-related research with university supervision and publication of pertinent results.

#### Recommendation to Continue Committee Four

The committee recommends that it be continued to pursue the following charges:

- 1. Suggest that compilation and writing of a soil survey report could be a graduate thesis.
- 2. Report on approaches to providing experience with computer manipulation (microcomputer. geographical and spatial information systems) of soil data for students and practicing soil scientists.
- 3. Propose that OPM use reference letters as components of its entry level soil scientist evaluation system.

#### Appendix I. Idealized Curriculum in Soil Science

Sixty participants at the 1984 Western Regional Soil Survey Work

Planning Conference completed a questionnaire designed to rate and rank

various courses required to earn a B.S. in soil science. The questionnaire

was a course list developed from the Proposed Soil Science Core Curriculum

of the 1980 Southern Regional Soil Survey Conference. These courses were

grouped according to Minimum Core Requirements for ARCPACS Certification

(Agronomy News, November 1983). Participants rated each course according

to the following criteria:

3 points = Course is necessary for a B.S. in soil science

2 points = Course is <u>important</u>

1 point = Course is desirable but not needed

0 points = No comment

Table 1 summarizes the ratings of all participants.

Table 1. Courses ranked by average rating score.

	Course	Ranking	Average (n=60)
Ι.	Professional core Courses		_ <del>_ '17-12-12</del>
	Soil Chemistry	1	2.83
	Soil Genesis Classification & Survey	2	2.81
	Introductory Soils	3	2.80
	Soil Physics	4	2.67
	crop sciences	5	2.28
	Soil and Land Use Interpretations	6	2.23
	Soil Fertility	7	2.00
	Soil Mechanics	8	1.91
	Drainage. Irrigation & Erosion Control	8	1.91
	Soil Biology and		
			1
			1
			1
			1
			1
			1

Table 1 (continued).

Course	Ranking	Average (n-60)
II. Supporting Core Courses-Basic Scie	ences	
General Chemistry and Lab	1	2.85
College Algebra	2	2.78
Computer Science	3	2.62
Physics	4	2.45
Trigonometry	5	2.40
Organic Chemistry and Lab	6	2.38
statistics	7	2.35
Analytical Chemistry	8	2.22
Calculus	9	1.88
Physical Chemistry and Lab	10	1.85
III, Other Supporting Core Courses		
Communications	1	2.74
Geomorphology/Physiography	2	2.49
Botany	3	2.39
Economics	4	2.39
Air Photos/Remote Sensing	5	2.26
Plant Identification & Taxonomy	6	2.26
Physical Geology	7	2.16
Plant Physiology	8	2.12
Ecology	9	2.08
Introductory Plant Science	10	2.04
Introductory Biology	11	1.91
Clay Mineralogy	12	1.89
Engineering	14	1.83
Hydrology/Groundwater Geology	15	1.74
Range Management	16	1.69
Glacial Geology	17	1.61
Historical Geology	18	1.56
Stratigraphy	19	1.51
Plant Pathology	20	1.43
Sedimentation	21	1.41
Meteorology	22	1.38
Introductory Animal Science	23	1.37
Petrology	24	1.33
Geochemistry	25	1.27
Animal Nutrition	26	1.09



Table 2 presents a" idealized curriculum in soil science. Table 2 was prepared by combining the rankings and ratings in Table 1 with the Minimum Core Requirements for ARCPACS Certification Agronomy News, November 1983). Courses were placed in Table 2 according to their average rating up to the number of credits required by ARCPACS in the various categories.

Table 2. Idealized Curriculum for B.S. in Soil Science

		Ш		11				<u></u>
	Course					Appr	ox. Quarter	Hours
7.	Professional	. j   ¢	ore courses					
	Agronomi	1111	ore Courses					
	Crop	\$	ences				9	
			iences					
	So	Щ	Chemistry			1111	4	
				assification	and S	Survey	4	
III	In		ductory Soi	ls		111	4	
II	so	ill	Physics	!		1	4	
				e Interpreta	tion		4	

Table 2 (continued)

Course					Approx.	Quarter	Hours
III. Other Supp	oorting Core Cour	rses					
Biology							
Bota						4	
	t Physiology					5	
Commun							
Speed	ch					4	
Tech	nical Writing					4	
Economi	cs					5	
Geology							
Geom	orphology/Physio	graphy				3	
Phys	sical Geology					3	
Enginee	ring					4	
*Addition	nal credits from	:				3 4 <u>3</u> 35	
Air	Photos/Remote Se	ensing				35	
Plan	t Identification a	and Taxonomy					
Ecol		v					
Intr	oductory Plant S	Sciences					
	oductory Biology						
Clay	Mineralogy						
	eralogy						
Hydr	ology/Groundwate	r Geology					
Rang	e Management						
Glad	ial Geology						
Hist	orical Geology						
St ra	it igraphy						
Plan	t Pathology						
Sedi	mentation						
	eorology						
	oductory Animal	Science					
	ology						
	chemistry						
Anir	nal Nutrition						
			**	Total	Credits	114	

<sup>\*</sup> Listed by order of ranking.
\*\* This leaves 70-80 credits for courses outside the soil science major.

In conclusion, Table 2 presents an idealized core curriculum in soil science. However, it is only a general guideline reflecting the requirements of ARCPACS and the ratings of participants in the Western Regional Soil Survey Work Planning Conference. For proper application, the information in Tables 1 and 2 must be interpreted and applied to particular situations.

Appendix II. Summary of Discussion Session on 5/21/84

# Charge 2

The secret rating systems could be obtained via the Freedom of Information Act. All discussants feel the current system is unfair.

University should send course outline to the raters in each state. It was suggested that OPH utilize reference letters in the application process.

# Charge 3

Recommendation 2 SCS Type Training

SCS, as leader of NCSS, has a responsibility to make training available to other agencies. The other agencies should be reminded of this. Several universities offer specialized training courses (Florida, Oregon State). The potential role of Extension should be explored. SCS is developing instructional modules which will be available to other agencies and universities.

Recommendation 3 Need for Practical Experience with Uses of Soils

Information

The Forest Service and BLN could offer land management experiences to SCS soil mappers. Exchanges could be very short and inexpensive to provide experience in a specific area.

Agency soil scientists also need training in legal, sociological, and economic skills.

Committee 5

Chairman: Robert Meurisse

This committee has completed final report which has been sent out and recommends to be dropped.

This recommendation is accepted, however, the final report will be presented at the 1984 meeting.

# Introduction

On April 27 and 28, 1982, Members of the Interpretation Committee met in Portland, Oregon for the purpose of responding to the interpretations submitted to the Committee Chairman per the February 23.1982 letter (copy attached).

Specific objectives wereas follows:

- 1. Review the responses and determine the appropriate disposition of each: i.e.
- a. Subject each item to a test of selected criteria for possible inclusion in the SCS-5, or other suitable location.
- b. For those items meeting the criteria, select criteria for making interpretations or make provision6 for obtaining criteria, 60 that they can be field tested during the next two years.
- 2. Respond to the suggestions for re-evaluating criteria for existing interpretations in accord with (b) above.
  - 3. Agree on a procredure for disposition of items not included.

The criteria for determining vhether the suggested interpretation should be included, vhether on the Form SCS-5 or not, are &s follows:

- 1. Must have more than local or limited regional significance.
- 2. Must be able to interpret from soil properties (or related land properties normally identified in soil surveys), or properties and first order interpretations.
- 3. Must have received a minimum of two responses plus a majority of committee members present concur.

Committee Members Present were: Dick Dierking, SCS, WNTSC, Lou Langan SCS, WNTSC, Don Jones, BIA, Oregon (one day) Jerry Latshaw SCS, Oregon, Byron Thomas, BLM, Oregon, Larry Walker, ELM (Range Conservationist, Oregon), Earl Alexander, USFS, Pacific Southwest Region, and bob Meurisse, USFS, Pacific Northwest Region, Chairman

#### Suggested New Interpretations

A total of 22 written and phone responses were received from the 60 letters requesting needed interpretations. The responses were highly variable and frequently reflected local needs or desires. Some responses dealt with existing interpretations and others suggested adding to the soil proporties. A summary of the request for new Interpretations is in Table 1.

Table 1. Summery of Responses received from the Feb.23 lester to participants requesting interpretations but not on 505-5.

Category	Da: Tecutic	101	1473111107 by (3=111#e
<del></del>			
Roope	_		
Fencab <u>e</u>	. 3		INTERP
Suitability for livestock gr	ating ?		L:NSP:IL
Benge conversion suitability	3		1;21;859
(includes mechanical treatme	,011		1;FSP;
Fange) and seeding	i		EL;INTERP
Rangeland Stilling	,		EL;INTERP
Rengeland discing	2		OC .
Astge side base	•		
Vondland/Forestry			
Pleatebalaty	3		INTERP
(includes regeneration hazar	d)		
Engineering	L		INTERP
Vosurieces rosts			1,457
Road Construction, location,=	1		
Vegetating road cuta/fills	3		1 1
Reveling out bank	2		-
Pipelines	•		escavations on Form-5
			61(1/1/1061 OF 104E-)
Veter Nepegement			
Later apreader suitability	1		L; see pond
,			reservoir areas
Vater catchments	1		1
Dreinability	1		L
,	_		
Provide/Statility/Compaction	<u> </u>		
Stability/Mass failure	3		MU, NSP
frosion polential (substrate	<i>i</i> ) 1		see K values
Sediment potential	1		NSP
Soi) disturbance	1		1
Compaction potential (suscep			ID
Pudeling (susceptibility)	2		ID
Tolerance for displacement	3	•	NSP
Vegetation/Productuity			
Ground cover at potental pro	ductivity 1		NSP
Ecclogical site	2		OC
(includes net primary produc	tivity)		
Agriculture			
Retrottere			ne they to ess
_3			
			î
- /			
Other			
Surtebility for chemical app	lications 1		L
(herbicides, fertilizer)			
Avalanche hezető	1		NSP
Suitability for prescribed f	ire 4		L
(includes susceptibility t			
burning lawage)			
Limitations for off-road veh	icles 1		20
Soil potential index	1		\$7,L
-			

A6 shown in the table, several of the suggested interpretations failed to meet the committee criteria for consideration to develop interpretations. The reasons were because of only local significance, inability to interprete from soil properties, insufficient knowledge, or the committee did not concuron the need. The specific reasons for disposition of the requests are explained by the codes in the key to table 1.

### Key to table 1:

Codes used to show the treatment or disposition by the committe

- L Local or site specific interpretation. In somecses, it may be dependent upon management objectives rather than soil properties. Specific soil tests also necessary for prescription.
  - MU Can be best treated in the map unit description per Ac.
- NSP Not interpreted by soil properties alone or at all. Also, soil properties are not the dominant factors'. Rather, it may be dependent on equipment or other consideration such as climate, geology, etc...
- INTERP Interpretation developed for use and testing and included in the appendix to this report.
- OC Being considered by other committee such as off-road vehichles committee or new committee to address range sites and correlation of range sites.
- ID Insufficient data or information to make as a general interpretation at this tine. As further information becomes available, interpretation might be developed
- EL- Developed category called Rangeland Equipment Limitations. Interpretations for specific equipment types are included in this report.
  - SP Best treated locally use of soil potential concept.

Because there were variations to several of the suggested range management interpretations, additional discussion and ay be helpful. The committee believes that suitability for livestock grazing and range conversion suitability have several facets to them. That is, some aspects are related to soil properties, but as a whole they are not.

Agreement was reached by the committee to develop interpretations for a variety of equipment under a general heading of Rangeland Equipment Limitations. It is recognized that this equipment may be used for purposes other that rangeland as described for each of the equipment types.

# Interpretations

The interpretations developed by the comittee include: Rangelend Equipment Limitations, including rangeland drill; rangeland disc plow; contour furrowing, subsoiling, pitting; and fencing; additional interpretations include: planting limitations; and unsurfaced roads. These interpretations are in the appendix to this report.

# Suggested revisions and other comments

Table 2 is a summary of other comments about existing interpretations, and their criteria, estimates of soil properties and other general comments. Committee explanation in response to these items follows:

# Existing interpretations and their criteria

- a. Reforestation potential This is a more general term than seedling mortality. Therefore it is more difficult to make an interpretation from soil properties. It is recognized that there are certain limitations to the seedling mortality criteria. These can be overcome by suggesting local criteria and publishing in the report. Also, the committee is proposing criteria for plantability which is one part of reforestation potential. This, combined with criteria relaxed to plant available water, as in the seedling mortality criteria, should be adquate for most situation.
- b. Suitability for logging This is a much more general intreprepation than equipment limitations and further removed from soil properties.
- c. Productivity in  $ft.^3/ac./yr$ . in place of site index This is included in the ordination symbol so already is part of the FORM 5.
- d. Drainage (properties below 40 inch depth) There are existing drainage guides in the states which are more appropriate than a west regional interpretation.
- e. Hodify irrigation criteria There are existing irrigation criteria in the states and are more appropriate because of site specificity.
- f. Woodland and wildlife suitability reasons for good, fair, poor Specific interpretations are made by class determining phase. Thus, reasons are provided.
- g. Improve criteria of existing interpretations This is a continuing process and is the responsibility of everyone in soil survey. Suggestions for specific improvements are welcome.

# Table 2

Ot	ther Comments about the Fom - 5	NO.
1.	Review existing interpretations and/or their criteria especially:	
	a.Reforestaton potential in place of seedling mortality	3
	b. Suitability for logging in place of or expansion of equipment limitation	1
	c. Productivity inft.3/ac./yr.in place of site index	2
	d. Drainage - address properties below 40 inch depth	1
	e. Hodify irrigation criteria	1
	<ul> <li>f. Woodland and vildlife suitability - reasons for good, fair,poor</li> </ul>	1
	g. Improve criteria of existing interretations (general)	1
2.	Estimates of soil properties	
	a. Improve T values	2
	b. kdd I values (wind erosion )	1
	c. hdd SAR	1
	d. Improve estimates of soil properties	1
3.	Present Form SCS - 5 satisfactory	7
4.	Hey need differen: format for survey of dominant use such as woodland rangeland, etc ( this option already exists)	1
	Enlarge Regional interpretations block (this can be accomplated by generating our tables)	2

# Estimates of Soil Properties

- 8. Improve "T" values This is a much debated subject (see: Journal of Soil and Water Conservation, March April 1982).
  - b. Add I value This is considered in wind erodibility group.
- c. Add SAR The committee recommends adding adjacent to salinity in the estimate of soil properties section atdalso recommends provision for ranges in values.
- d. Improve estimates of soil properties This is a continuing process and is the responsibility of everyone in soil survey to ensure that the best estimates are made. Suggestions for better guides for estimating properties are welcome. It is always possible to improve estimates and/or measurements of soil properties. This can be done by making better use of appropriate research results, consulting experienced soil scientists and users of soil surveys as well as improving field sampling techniques and recognizing inherent soil variability. Suidelines for estimating

- 2. Establish a standing comittee of NCSS representatives, with revolving members, to review new and revised interpretations and criteria applicable to the National Cooperative Soil Survey program. The comittee would be similar in make-up and function as the comittee that reviews proposals for mending Soil Taxonomy.
- 3. Use all available and prudent opportunities to ensure that soil survey party leaders, and others making and using surveys, fully understand the options available for making and publishing desired interpretations.
- 4. When new or existing interpretations and criteria have had sufficient testing and review, ensure that they are published in appropriate handbooks and distributed to NCSS cooperators. For interim purposes, proposed interpretations should be placed in handbooks, given tentative status, and after testing and review, approve or disapprove for further use.

# Appendix

#### Rangeland Equipment Limitations

This is a group of equipment usually identified by the "rangeland" name, but with application to a variety of situations. Host criteria are from the ELM handbook, but include some modifications. The interest is to confine the interpretations to the specific equipment. The interpretations do not include site/environmentcriteria because of the variability of these and the necessity of considering local conditions.

#### Rangeland Drill

	Degree 0	<b>f</b> Limitations	
Factors Affecting Use	Slight	Hoderate	Severe
Soil depth (inches)	>10	>10	<10
Rock fragments - Su	rface 6 inches		
Stones (2)	<3	3 - 20	>20
Cobbles (2)	<15	15-35	>35
Gravels (%)	<35	35-60	>60
Rockiness $\frac{1}{2}$ (2)	<3	3-15	any rock outcrop complex
Slope (2)	015		

Description - The rangeland drill is used for seeding species suited for domestic livestock, wildlife, forage, and/or erosion control purpose, including slide trails, roadsides and other places. The ratings are intended to reflect equipment useage or ease of mechanical operation for the intended purpose of drilling seed into the soil. It assumes that species adapted to the conditions or site and dates of application are appropriate.

1/ he rockiness factor is to be used for map unit purposes.

Rangeland Disc Plow

Factors

Degree of Limitations

Affecting Use	Slight	Moderate	Severe
Soil depth (inches)	>20	IO-20	<10
Rock fragments - Sur	face 6 inches		
stones (%)	<3	3-20	>20
Cobbles (%)	<15	15-35	>35
Gravels (%)	<35	35-60	>60
Rockiness1/	<3	3-15	any rock out crop complex
Slope	<15	1520	>20
Texture	all others	c,sc,sic,sand, fs, cos, vfs	-

<u>Description</u> - The rangeland disc plow is a specific type of disc plow designed for rugged use. It is used for site preparation, increasing infiltration and alleviating compaction in rangeland and forested areas.

Contour Furrowing, Subsoiling, Pitting

Degree of Limitations

	DC	gice of Limitetio	<u> </u>
Factors Affecting Use	Slight	Moderate	Severe
Soil Depth (inches)	>40	20-40	<20
Rock Fragments - Sur	face <b>6</b> inches		
stones (%)	<3	3-20	>20
Cobbles (%)	<15	15-35	>35
Gravels (2)	<35	35-60	>60
Rockiness	<.01	<.01	>.01
Slope	<8	8-15	>15
Texture2/	l,sil,cl, scl, sicl	sl,fsl,sc	s,ls, sic,c

2/This is for purposes of evaluating effectiveness of the practice, rather than equipment limitation per se.

<u>Description</u> - These practices are for site preparation, Increasing <u>infiltration</u>, increasing root penetration and <u>aleviating</u> compaction. Contour furrowing and pitting are <u>more</u> likely to be applied to range situations. Subsoiling <u>may</u> be <u>applied</u> to forested areas in skid trails, roads <u>and</u> landings, in addition to range uses,

This interpretation may be of questionable value. Therefore, potential users are requested to advise appropriate people about its utility.

Tree Planting Linitations

	De	egree of Limitation	
Factors affecting Plantability	Slight	Hoderate	severe
Coarse fragmer.ts vith	io surface <b>foo</b>	t	
Gravels and Cobbles(2	<b>)</b> <35	35-60	>60
Stones and Bouldler	s(X)<15	15-50	>50
Soil depth (inches)			

# Unsurfaced Roads

Degree of Limitation

		Deg	<u>ree of Limitatio</u>	on	
	ctors Affecring cation and use	Slight	Moderate	Severe	Restrictive Feature
1.	Perma Frost			Ice	Perma Frost
2.	Depth to Bedrock(in hard soft	) >40 <u>1</u> / >20	20-40 <20	<20	Depth to rock
3.	Depth to Cemented pan(in) thick (>3") thin (<3")	>40 >20	20-40 <b>&gt;20</b>	<20	Cemented pan
4.	2/3/ AASHTO Group index number	0-4	5-a	>8	Lov strength
5.	2/ 4/ AASETO	Class	A-4,A-5	A-6,A-7, A-E	Low stength
6.	w <sub>a</sub> ter Table (in)	>60	40-60	<40	Wetness
7.	Slope	0-30	30-60	>60 <u>1</u> /	Slope
8.	Flooding	Non Protected	Rare	Common	Floods
9.	Potential	Low	mi . v		Durant Bathian
	Frost Action	Moderate	High		Frost Action
10	. Shrink-well	Low	Moderate	Higb	Shrink-swell
11.	_5/Fraction>3in (Wat PCT)	<25	25-50	>50	Large stones
<u>1</u> 2.		alan .	SIL, SI, FSL VFSL, L		Dusty

 $<sup>\</sup>underline{1}/$  If slopes are such that hard bedrock is exposed during road excavation — reduce rating to moderate.

Description: Limitation ratings are for the use of soils for planning and locating unsurfaced roads that normally lack surfacing and are expected to carry truck or other automobile traffic when free of snow. The roads consist of the underlying local soil material, or subgrade and the road surface of compacted local soil material, or gravel. The roads may be graded to shed water. Normally, the roads are constructed from the soil at hand.

The suggested criteria are the best the committee believes it can do at thir time. We recommend that engineers and other review and test the criteria to determine their suitability.

Fencing is the construction and maintenance of wire barriers that restrict movement of livestock. The barriers are constructed of metal, or treated or untreated wooden posts buried at least two (2) feet into the soil with at least three (3) wires suspended between the post, but more commonly five (5) wires.

The ratings are based on the soil properties that influence ease of setting posts in the soil to the desired depth, maintaining the desired wire tension, and keeping replacement and maintenance cost to a minimum over the projected life of the fence. Excavations for wooden post holes are commonly made by power auger, while metal posts are hand-driven into the soil. Depth to bedrock and cemented pan, and large and small stones, influence the ease of excavation of post holes and driving posts. Flooding and depth to high water table may restrict the season in which the fence can be constructed. Flooding can also influence maintenance and replacement cost. Depth to high water can influence maintenance cost and require deeper post settings to offset the soil's low strength when saturated. Shrink-swell characteristics of the soil will require deeper post settings or rock-jacks to maintain vertical post alignment. Permanently frozen soil may lose its insulation qualities when setting posts and result in thermokarst topography. Post alignment and desired wire tension is often difficult to obtain on sandy soils due to their in-place low strength. Maintenance can also be a problem due to soil blowing. Frost action characteristics of the soil may result in frost-heaving of the posts. Slope influences the ease of using power augers and transport of supplies. It can also result in surface creep during wetter seasons such as the spring snow melt period. Soil reaction and salinity will influence the type of post used and maintenance cost due to corrosivity.

Soil map units that contain more than 10 percent rock outcrops should be rated SEVERE.

# FENCING LIMITS

PROPERTY	SLIGHT	<u>MODERATE</u>	SEVERE	RESTRICTIVE FEATURE
USDA Texture			ICE	PERMAFROST
Flooding	NONE, RARE	OCCASIONAL	FREQUENT	FLOODS
Depthto Bedrock (in) Hard Soft	> 40 > 20	2 0 4 0 10-20	< 20 < 10	DEPTH TO ROCK
Depthto Cemented Pan (in) Thick Thin	<b>&gt; 40</b> 7 20	<b>20-40</b> IO-20	4 2 0 <b>&lt; 10</b>	CEMENTED PAN
1/ 2/Fraction 3" (st per)	<b>&lt;</b> 25	25-50	7 5 0	LARGE STONES
1/ 2/Coarse Fragments (wt pct)	< 25	25-50	* S 0	SHALL STONES
Shrink-Swell Depth to High Water Table (Ft) Slope	> 2.0 < 30	1.0-2.0 30-60	H1GH < 1.0  > 60	SHRINK-SWELL WETNESS PONDINC SLOPES
1/ 4/USDA Texture Potential Frost Action Salinity (mmhos/cm) Soil Reaction (pH)	-	LCOS,LS,LFS,LVFS HIGH >8 < 3.5	COS,S,FS,VFS	TOO SANDY FROST ACTION EXCESS SALT TOO ACID

Weighted average to 24 inches. 1.

Sum (100 + % passing No. 10 sieve) and fraction 3 in. Use dominant condition for restrictive feature.
 Thickest horizon between 0 to 24 inches; if less than 12 inches thick rate anderate.
 If soil occurs in udic or aquic moisture regimes, rate one class better if experience confirms.

2550 Soil Survey

23. 1982 rebruary

Soil Survey Interpretations Same teacher and a subject of the Fill and

Participants .

# REPLY DUE APRIL 1: 100000

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The recommendation is to canvas all participants to determine that interpretations are needed, but not presently on form SCS-5. Becember that our fundamental purpose is to make sound interpretations for a variety of the kinds of lands and for varying levels of soil survey. Before responding, be certain you are thoroughly familiar with the form 5.

If you propose an interpretation, please send the name(s) of persons having expertise in that area. Also, if you have criteria for a proposed interpretation, please send them along with your response. The same throughout the same that the first

Please send your proposed interpretation to me by April 1, 1982.

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ROLEAT T. MEURISCE

ROBERT T. MEURISSE Interpretations Committee Chairman

ATMeurisse:bfl 2/22/82 022282RH1 #4

## Conmittee 6: Correlation of Ecological Sites

Chai rman: Larry Walker - BLM Robert Klink (BIA-AZ) Doug Harrison (SCS-ID) James Hagihara (BLM-RMF & RSS) Dr. Fred Hall (USFS) Leonard Vollard (USFS) Ray Mann (SCS) Thor Thorson (SCS) Eugene Eggleston (BIA) Dr. Gerald Simonson (Oreg. State) Richard Dierking (SCS-WTC) Charles Lenfesty (SCS-NM) Dr. Alan J. Busacca (WSU-WA) Gerald Latshaw (SCS-Ore.) George Hartman (SCS-WY) Owen Carleton (FS-Reg. 3) Will Moir (FS-Reg. 3)

Objective

To develop a framework of guidelines for the process of correlating ecological sites among themselves and to soils.

### Charges:

- (1) Develop recommended standards and criteria for taxonomy of ecological sites.
- (2) Develop recommended criteria and procedures for the correlation process.
  - A. Among ecological sites.
  - B. Between soils and ecological sites.
- (3) Identify necessary ADP procedures and data storage frameworks for correlation (2A and 2B).
- (4) Determine the organization and support functions which would be needed to implement and maintain a program of ecological site correlation.
- (5) Develop a recommended structure for a technical steering committee for overall direction of ecological site correlation efforts.

# Western Regional Technical Work Planning Conference May 20-25, 1984 El Paso, Texas

# Committee Report

on

Ecological Site Correlation
Stephen G. Leonard, Committee Chairman

### <u>Preface</u>

Because of administrative conflicts of the previous committee chairman, Larry Walker, the **committee** did not have a chance to interact and provide recommendations as a group. Fortunately, Larry provided a report reflecting his own analysis and recommendations for the charges assigned, which served as a focal point for the committee discussion at this meeting.

The **charges** of the **committee** are broad in scope and previous approaches to each have been both diverse and controversial between agencies, disciplines and academic groups. Bach, **of** course, has many good ideas and approaches but resolution is not likely in the near future.

Therefore, we recommend that the **committee** be maintained and continue to address the charges **assigned**. Because of the complex nature of **the charges** and concurrent work on similar issues by other organizations, the charges may have to be amended and narrowed in **scope**.

### Charges and Recommendations

- Charge 1: "Develop recommended standards and criteria for taxonomy of ecological sites."
- Recommendation 1: The **committee will** review existing work on the taxonomy of ecological sites and determine if this should remain a charge or if it should be amended, modified, **or** tabled for future consideration.
- Charge 2: "Develop recommended criteria and procedures for the correlation process."
- Charge 3: "Identify necessary ADP procedures and data storage frameworks for correlation."
- Charge 4: "Determine the **organization** and support functions which would be needed to implement and maintain a program of ecological site correlation."
- Recommendation 2: Inasmuch as charges 2 through 4 of the committee are equivalent to the charges of the National Soil-Range Team (NSRT), the committee should have the opportunity to review existing proposals by the NSRT and continue to work in cooperation with the NSRT on charges assigned.
- Charge 5: "Develop a recommended structure for a technical steering committee for overall direction of ecological site correlation efforts."

Recommendation 3: Additional expertise from the ecological and vegetation sciences such as regional or state ecologist, range conservationist, forester and wildlife biologist should be solicited and with this additional expertise would become the technical steering committee for ecological site correlation efforts.

Because of the interrelationships between site identification and correlation with use and management implications, the comittee proposes to add a sixth charge: "Develop criteria for ecological site interpretation purposes."

### Summary

Proposals by the NSRT on site correlation and Resource Value Ratings (Charge 6) will be distributed to committee members for review, comment and alternate proposals, if any. A consolidated report will be submitted to the regional steering committee chairman and the Director, Ecological Science, SCS.

SGLeonard 6/6/84

Stephen G. Leonard National

# HESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE EL PASO, TEXAS -- MY, 1984

### RECOMMENDATION 111

Charge 2: "Develope retmended criteria and procedures for the correlation process."

Appropriate correlation procedure5 will be substantially affected by the type of correlation organization established. In general, correlation procedures should follow those established for soils.

- **-Descriptions of** ecological sites and correlation to soils should be developed and proposed by a qualified party leader at the field level.
- -A state correlator should review proposals from the field and make recommendations for final correlation.
- A regional correlator should review recommendations from the states and have final authority/responsibility for certification.
- -Correlation should be limited to only those ecological sites rhich are identified in conjunction with soil surveys which are covered by an approved Henorandum of Understanding.
- -As rith soils, the establishment of new ecological sites should be liaited to sites which make up a significant land area.

## RECOMMENDATION IV.

Charge 1: "Develope recommended standards and criteria for taxonomy of ecological sites."

The purpose of this committee (the development of a recommended method of correlating potential vegetation with soils) must be the driving farce of any taxonomy proposed.

- -The taxonomy wist be based solely upon vegetation attributes.
- The taxonomy must be capable of accepting ecological sites from most of the multitude of existing classification systems.
- -The taxonomy should be developed thru a series of approximations, each followed by testing with actual application over a broad area, in an approach similar to that used in the development of 'Soil Taxonomy'.
- "The resolution of the initial approximation of the taxonomy must be compatible—rith—the—level—of resolution—used by the cooperator employing the least detailed—level—of resolution.
- The taxonomy must be useable in all areas covered by the National Cooperative Soil Survey and by all

cooperating sembers of the NCSS.

for maximum utility, the taxonomy should be amenable to ADP applications.

### RECOMMENDATION V

Charge 3: 'Identity necessary ADP procedures and data storage frameworks for correlation.'

The workgroup did not progress to this point. Basic ADP needs could probably be segregated into three areas:

- -Data storage and retrieval of raw data. A good relational data base would probably satisfy this need.
- -Analysis of data &ring the correlation process. **This** could involve **such** applications as cluster analysis, ordination, **regression**; **similarity index**; and association tables.
- -Data storage and retrieval of 'correlated sites'. A relational data base would be optimum for this application, particularly if soils data could be stored in the same data base as another 'relation'.

### NATIONAL LIST OF SCIENTIFIC PLANT NAMES

As envisioned, ecological sites would &rive their taxonomy from plant names. Therefore, the workgroup reviewed the latest edition of the National List of Scientific Plant Names.

- -NLSPN does not adequately provide for rare, threatened, and endangered plants (most are sub-taxa which are not included).
- -NLSPN is confusing and has not provided a clear authority in the case of many synonyms.
- -NLSPN has not adequately addressed some of the more important and widespread plants, such as the sagebrush complex.
- "The 'family organization of NSPN is awkward to use. NLSPN should be organized by genus, not by family.
- "Some cooperators are not presently using NLSPN. Hanual conversion of their existing data and records would be expensive and time consuming. An ADP conversion program would need to be developed before these cooperators could participate in interagency correlation efforts effectively.

### A POSSIBLE BAND-AID

This committee was formed because the NCSS identified a. pressing need for the correlation of enclosical sites to facilitate the tasks of soil correlation. Put another way, lack of adequate correlation of ecological sites is hampering soil correlation.

SMM. PIPO/JUOC, ARTR2/PUTR2, A6SP-FEID, CM. USES

PIPO/JUOC, ARTR2/PUTR2, AGSP-FEID

CONCLUSION

THIS REPORT IS BASED SCIELY UPON MY PERSONAL PROJECTION OF WHAT WOULD HAVE REEN PRODUCED IF THE COMMITTEE HAD COMPLETED IT'S BASKS. IT HAS NOT BEEN REVIEWED BY THE WORKGROUP OR THE COMMITTEE AT LARGE, THE PROPOSED "MAND-AID" CLASSIFICATION IS PURELY OF MY ONE FABRICATION PASED UPON MY PERSONAL EXPERIENCE AND REVIEW OF THE STRENGTHS AND SHORT-COMINGS OF EXISTING CLASSIFICATIONS.

# Committee 7: Coordination of Data Base Systems

Chairman: Shelby Brownfield

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Don Stelling (SCS-NCC)

Harry Sato (SCS-HI) Ron Hoppes (SCS-CA)

Ferri s

Committee 7 (contd.)

- (2) Identify the kinds and location of soil and/or natural resource data bases and the hardware and software capabilities associated with these data bases and potential retrievability.
- (3) Determine potential for integrating existing data bases for making available relevant, valid and reliable soil and natural resource data from these data bases.

# COMMITTEE 7

# COORDINATION OF DATA BASE SYSTEM JOINT WEST/SOUTH REGIONAL WORK PLANNING CONFERENCE EL PASO, TEXAS

### May 20-25, 1984

Coordination of Data Base Systems with cooperators of the NCSS is essential to present compatible soils and resource data to decision makers (landowners, land planning groups, land management agencies, etc.).

The three charges and brief abstract of activities, discussion, and needs are:

Charge 1 - Identify the data base capabilities needs in the Western Region by agencies and clientele having responsibility for, or being served by, the National Cooperative Soil Survey.

- a. Data should need to input once.
- b. Data base files need to be interactive.
- **c.** Systems need the ability to transfer data between offices within an agency or between agencies.
- d. System needs capabilities of ad hoc searches and manipulation of data-creating new files.
- e. System mus t have easy maintenance and update of the data files.
- f. Must be user friendly.

Recommendation: That a national committee on Data Base Management be established with a subcommittee on Geographic Information Systems (GIS) (digital cartography and digital data base).

Charge 2 - Identify kinds and locations of soil and/or natural resource data bases and the hardware and software capabilities associated with these data bases and potential retrievability.

There are several data base systems that have been developed and/or developed, ranging from some very simple to very complicated. Several people have developed a program for some specific job but the program has no documentation and is not easily transferable to other users. However, there are several operational systems mainly at the national level and are in large main frames. Some of these are:

- a, Soils-5 program, Iowa State Computer Center, Ames, Iowa
- b. CERL Corp of Engineers program using Soils-5 data, University of Illinois
- c. SRIS System 2000, Ft. Collins, Colorado
- d. NSSL Laboratory data and some state university laboratory data. NSSL data is in the Nebraska State Computer Center in Lincoln, Nebraska
- e. Westfornet Reference data base on literature of interest of USDA Forest Service
- f. EPIC
- g. Climatic data, National Climatic Center, Asheville, North Carolina
- h. Soil Engineering **Test Data –** USDA Washington Computer Center, Washington, D.C.

- Soil-woodland and Windbreak Data Base USDA Ft. Collins Computer Center, Ft. Collins, Colorado
- j. MUUF Map Unit Use Pile. Iowa State University Computer Center, Ames, Iowa
- k. Pedon Coding Program. University of Minnesota
- 1. BLM-REX Program Denver BLM Service Center

There are several data bases that are being developed or tasted. Among these are:

- 1. Soil Range Data Base. This base will be located in the USDA Computer Center, Ft. Collins, Colorado.
- 2. **STATSGO** (State Soil Geographic Data Base). This **is** in a planning state and will be a digitized collection of integrated state general soils map.
- 3. NATSGO (National Major Land Resource Area Geographic Data Base). Digitized major land resource area map.
- 4. soil Data Base Management (DBMs). This is being developed by SCS National Headquarters.
- 5. Geographic Information System (GIS). This is being developed in SCS concurrently with the DBMs.
- 6. National Pedon Coding. Developed at NSSL and being tested in several states.
- 7. Soil Survey Legend Program. Developed in Nevada by SCS to be used on Apple II computers. Now being tested.
- 8. Other field programs being tested are mainly geared toward the microcomputer rather than main frames or minicomputers. System is being used by Bob Kukachka, SSPL, Burley, Idaho. This is an interactive system where data from several files can be used for development of a new file, eliminating the need for duplicate entry of data. Several other employees from other states are also working on programs.

Recommendation: That a catalog of data base programs be developed. This could be developed through a" interagency committee in each region and they report at the NCSS national meeting. The leadership should be at the NTC level. Methods of transmitting information to the field could be a NCSS newsletter or a central computer file.

Charge 3 - Determine potential for integrating existing data bases for making available relevant, valid and reliable sort and natural resource data.

Presently there are only a few data bases that are accessible by other agencies. Among these are the SCS-Soils 5, CERL, and possibly the SRIS. Some like NSSL, EPIC. MUUF data can be obtained through the agency. The

Forest Service has several programs at the USDA Ft. Collins Computer Center that could be of value to other agencies. Information on these are through the Forest Service.

SCS - Gordon Decker is working on a coordinated data base system linking all soils data bases within SCS together. This includes national files and NSSL files.

The RLH-REX Program - Denver BLM Service Center, could be used by other agencies through a contact with BLM.

The kinds of hardware to access the different data bases is variable. Within SCS most national data bases can be accessed by the Harris terminal, IBM display writer, microcomputers, and some word processors with acceptable communications systems. Forest Service and BLM can access through their present terminals.

Training is a" important item that was not included in the charges. If hardware and software is available and staff is not trained in its use, it is of little value. There are different levels of training needs.

- A. Computer familiarization. There is a need to acquaint people with computers that have "ever been around or had experience with them. Computers can be very intimidating so a basic familiarization course may be needed, especially for those employees who are older and didn't have computer equipment in school.
- 8. Training for specific programs and specific hardware. When new software or new hardware is acquired, training must be provided. Where there is a major input or change. **a** progressive training plan may be needed. To make the use **of** ADP most effective, efficient, and cost saving, a comprehensive training program is essential.
- C. Training in application management. Some managers need to understand the overall application of different software and hardware. They will not need to know all the steps in the operation but it is essential they understand the application. Training at this level will be broader than training to those individuals actually operating the equipment. One major problem now is that many managers do not have an understanding of computers and their applications. Employees they supervise know what they can do but management doesn't understand and this creates a lack of communication.
- D. The university representative suggested that they evaluate their programs and incorporate computer use training in student requirements.

Committee 7: Members

Chairman: Shelby Brownfield

Dr. Robert D. Heil(CSU)

Dave Anderson - Soil Scientist, SCS, USDA, Department of Agronomy, Colorado State University, Fort Collins, CO 80523

Committee 7:

-4-

### Briefing Paper

Coordination of Data Base Systems
Joint West/South Regional Work Planning Conference
F1 Paso, Texas
May 20-25, 1984

**Coordination** of Data Base Systems with **cooperators** of the NCSS is essential to present compatible soils and resource data to decision makers. (Land owners, land planning groups, land **management agencies**, etc.)

Items of consideration are:

Hardware - Kinds, compatibility
Software - Compatibility
Multi-level interaction - Field, regional, National
Multi-agency interaction - SCS, BLM,FS, states
Multi-legal - Multiagency interaction
Data processing - Remote sensed data, digitizing, electronic image processing, soil data processing.

What can or is being done at the field level?

At this level we need access to basic soils information. We need the capability to get information at the series level. The information should be available in a way that allow searching and sorting on a number of criteria. The SIRS program module in the Environmental Technical Information System is one such application. ideally the SCS Form 6 information would also be available so that mapping unit specific data could be obtained.

The ability to integrate USCS information, either through a Geographic Information System (GIS) or by itself would also be highly beneficial. This would al 4 T@ÿsitheoIRS duceheop Geograpm (informattem) Tj ET 8220.0800021 09 5

Kind of equipment needed for Soil Survey field office operation:

- (a) Micro computer 16 bit or 32 bit processor, 500 K to 1 Megabite RAM; with graphics, interactive programs, work processor, communication capabilities.
- (b) Access to IMAGE analysis equipment for quantifying mapping unit components, inclusions, proportions of different components using Landsat data, etc. Type of equipment: Measureonics Co. model ii or IJI or RIPs terminal, etc.
- (c) Printer capable of printing graphics, letter ouality for reports, etc.
- (d) Hand held, portable input devices eliminating the need to write most data. These may be bar graph activated or key input or both.

To: Shelly Brownfield State Soil Scientist Boise. ID

Enclosed is a brief discussion of what I have been doing at  $\bullet$  v rolls office with an IEM-PC micro computer.

# Background

Approximately 3 years ago computer technology became available to help support our soil • "rvev activity. At that time we entered into a full time contract with the BLM. We agreed to map their administered lands to SCS standards at the Order 3 level. The BLM's need for rapid availability of our • roping units and data prompted us to use their word processor and mainframe computer.

This experience prompted us to explore the possibility of using a micro to do this work in our spils office. After looking the market over. A factor Shack Hopelliwas purchased; 64k, 2 55 FP drives and a printer. The software used was fadio Shack's Scripsit 2.6 and Profile II. These two programs gave use the two most necessary functions; ie. word processing and database magchent. Over the course of B months we developed of datasystem which enabled us to generate M.U.s.legends and Tech guide of rtrrirl. The word processor was not very easy to use; it required cumbersome control codes and it was difficult to reformat text. The data bare was our most easily used program and we quickly had o sizeable amount of

Noth officer now use the  $\bullet$  rchine On a regular basis. Report generation is much faster and updates are made  $\bullet$  acidy.

The real power of the word processor is realized in creating Map Unit descriptions and Taxanoaic unit descriptions. These documents are assembled from prewritten edited text and drift erQed from the keyboard. A tasi that used to take hours now can be done in IS to 25 minutes. Another benefit is that the now document is incrintive available (previous to this alldocument erresbive was done at the S.J. with a i-8 month delay). Updating, when necessary, can be done immediately and the document reprinted for a fresh priginal with eliminel amount of retyping. This is a real benefit for rii users.

Is presented the Diffs for its "supposed" base Of USC and power. it has turned out to be quite flexible but lacks a really good report generator. The word processor can access the Diffesand convert them directly into • cree file. ibis provides another • echSnirm togenerate reports.

The fighthility of the DB program allows drtr fields to be inserted as they are needed and new data bases can be created from parts of existing ones. The DB is also relational and other DB scan be updated automatically when properly linked together.

The DD is invaluable when faced with report generation and lack of personnel and time to do the job anurily. Custom reports tan be generated rapidly and standard reports (format stored in a report file) can be generated in sinutes.

These systems have allowed • e to serve the speciality needs of the F.G. and other users in • timely and efficient manner. Considering I am • soils party of one. these tasks would have otherwise required a great deal of time and taken • e • \*Sv from other duties. In some cases I could not have done th? work at ail.

The data system i am building is dynamic. It can respond to user needs fairly readily. As it changes and grows it becomes more versatile. I for see this data base as being able to create the bulk of a modern soil survey or nuscriot while at the same time increasing consistency and quality of the document.

The handouts 1 prepared Show some of the different outcut the system generates for my and the F.D.'s needs. The overheads demonstrate the basic relationships between the programs and there effect on the offices involved.

The first example, labeled SOILS OFFICE/FIELD OFFICE shows some of the data pathways involved and their impact on the F.G.. Their are more interrelationships but the chart becomes too busy to protray then all. The Soils Office (or soils data base) provides a great deal of information to the F.O.. It forms the basic core of  $\bullet$  oSc of the planning rnd application activities that go on. The F.G. can assemble this information rnd produce reports, plans, etc..

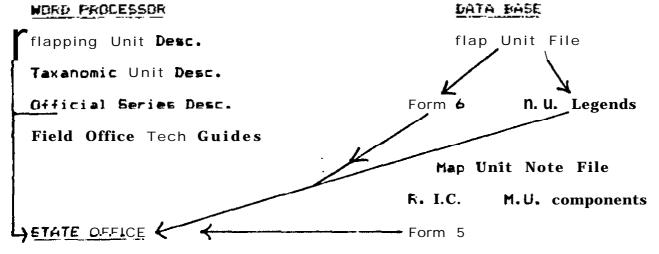
The second example, labeled SDILSOFFICE/STATE OFFICE indicates some of the pathways that support the S.U.. Generally I tried to show that the

electronic process can eliminate the need to reprocess informationat that level. What • "er is input at the field level

Bob Kubiello

# SOILS OFFICE/STATE OFFICE USE OF MICROCOMPUTERS

# SOILSF | CE



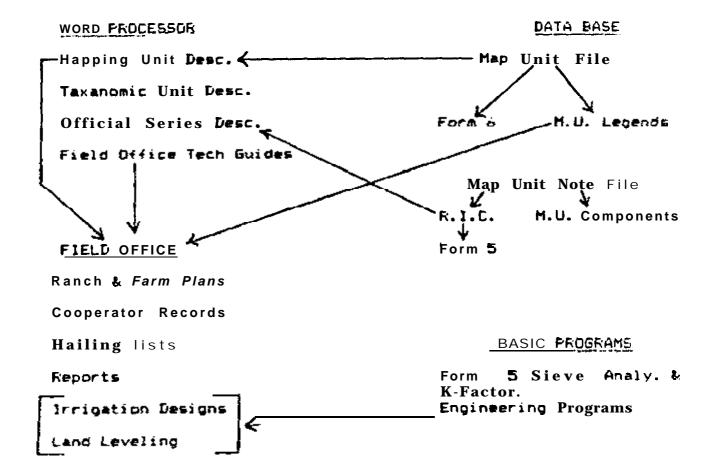
State Office computer can receive data from the field at any time and check progress. Many surveys can be compared and duplication of effort can be eliminated.

Party Leaders can exchange data easily and design napping units that cover- a broader area.

State Off ice no longer would need to reprocess data from field. All MUD's, TUD's, Official Descriptions, etc. are stored in the Field/Soils Office computer. The records can be retrieved for Reviews and modified as necessary. When Survey is finished at 1 data can be transmitted directly to the NTC and input into the automated printing system.

# SOILS OFFICE/FIELD OFFICE USE OF MICROCOMPUTERS

# SOILS OFFICE



# UPDATE OLD SURVEYS

Us e DATA BASE and WORD FROCESSOR to sort and manipulate old and new data to produce new document.

When current surveys need to be updated data stored electronically tan be masily retrieved and modified as necessary.

22 Nov 1963

# The Use Of Micro Computers in . Soils Ofircr

### Burley Soils

# Uses

- 1) Word Processing.
- 2) Data Base Storage and Retrieval.
- 3) Data Manipulation.
- 4) Electronic Comminunication (Mail. Form 5's. Legends and Taxanomic Tables From Other Surveys. Accessing Outside Data Bases; q. CERL. AGNET. etc.).
- 5) Computer Graphics • q. Creating Block Diagrams; Digitizing Topographic Sheets and Displaying Them on the CRT to Help With Block Diagrams; Overlaying Soils, Geology, and Topographic Information to Help in Landform Apalities.

The work in a Soils Office involves a great deal of text generation. With the continual need to update information a word processor quickly becomes becomes indispensible. Agreat deal of time is saved by not having to retype an entire document after each revision. Many times • new file can be created • imply by putting together parts Of already existing files. The ability to move text from one document to another is a great time saver and is less subject to errors.

# Essential Software Requirements

- 1) ALL PROGRAMS MUST BE ABLE TO EXCHANGE DATA!
- 2) Programs should be relatively asv to learn without sacrific-ing versatility.
- 3) Programs should be optimized for the computer being used rather than "one size fits all".
- 4) Frograms should share et least some of the same basic commands so as to avoid confusion when switching between them.

### Essential Hardware Requirements

1) Hardware must allow for future technological advancements:

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M.O. NerE:Strevell silt loam. 1 to 3 percent slopes

\* ACRES: 12, 260 PROV/APPROV: A CAPABILITY NIRP: 65 IRR: 25

FORM 5 NO. R FACTOR RANGE SITE % OF UNIT ACRES JUNIE, INVADING t.65 t10.421 tt ist 501L:100748 (.47 :525-11 r. r Ø ino Sūli: +-Dro 50it: :. : # : # PRECIPITATION AVE. ANNUAL SOIL TEMP F. ELEVATION RANGE LOW: 47 HIGH: 45

LOW:08 HIGH:12 LON: 4400 HIGH: 5600

AVAILABLE WATER CAF. LOCATION OF MODAL SITE

LOW: 03 HIGH: 04 NAF #: 24975 SEC: 23 T. 155 R. 26E # OF NOTES: 25

30K INCLUSIONS	% OF UNIT	ACRES	RANGE SITE	
#1:Darkbull GR-SIL	:.05	: 367	16116-1	
#2:Declo SIL, Saline	:.07	: 858	11-9541	
#T:Idahome SIL	:.05	: 613	(D28-11	
#4:	<b>.</b>	: 0	Į.	

TOTAL ACRES OF INCLUSIONS = :1,838

Print out of a data base record as it appears on the CRT screen

State District or Area Office Level

The equipment would **need to** be of greater **RAM**, storage and **be** able to manipulate large volumes of **data for digitized** maps. This equipment **would** be able to access National programs, input and change certain items in national data bases. A **mini** computer is a minimum needed.

We would now be more interested in **reginal** planning and gathering less specific data. The need to access specific information would **still** be present but not as pervasive. We would need to be able to access possibly the same data bases as the field needed to, but now would conduct searches on more general criteria eg. Mollisols in MLRA B13 with slopes of 2 to 8 percent with a K .37 that are **predominately** farmed. This type of data acquisition would be very beneficial to the regional planner.

At this level access to a **GIS** would be highly desirable. Planning and broad **interpretations** could be accomplished rapidly and accurately. Critical areas could be located more accurately and rapidly than is now the case. As more specific data was needed one of the complimentary data bases could be accessed. This type of data **acquisition** system would allow very flexible planning and interpretations to made.

The State Office or equivalent level needs digitizing capabilities for soil and other resource data along with suitable system like MOSS/AMS or others that can be interfaced. The capability for electronic map building can also facilitate the soil map finalizing. The scil map finishing is not the primary need for digitization but a by-product. The major benefactor of digitizing is the soil map and other resource data user. Special interpretive makes can be readily developed.

National Level - At this level major data bases would be maintained in storage and manipulated by large main frames. These data bases would be accessible by the field office micro's, state or equivalent micro's and mini's, and regional office micro's and mini's. The following two papers discuss some of the data bases that are available or they are being developed.

# NATIONAL SOIL SURVEY DATA BASES William U. Reybold 1/

Introduction - The USDA **Soil** Conservation **Service (SCS)**, **as** part of its effort in the National Cooperative **Soil** Survey, **has** established national soil survey computer dtta **bases** to improve **the** manipulation and **retrieval of soil** resource information.

People involved in land use planning, agriculture roltttd business, and land management often have difficulty locating and interpreting soil data. Often the soil data are not in a form that permits easy analysis, particularly if the data must be analyzed together with other resource information.

Soil data, together with other natural **resource** data, are unique in that spatial distribution and variability on the landscape art important **components.** Those who use soil data often need to integrate them with other spatial data.

To provide flexible, rapid access to and retrieval of **soils** data, SCS has established computer data bases for **soil** performance, interpretation, and geography. The **data bases** will be **linked** by **a** data base management **system** and graphics processing system.

## Soil Performance Data Bases

measurements taken at carefully selected crop, woodland, and range sites. These data are used to confirm field observations, make predictions of soil performance on roils with similar properties, and to help ensure proper soil classification and more useful interpretations. A brief description of each data base and its status follows:

- Soil Characterization Data Base. This data base contains laboratory test data for more than 8,500 soils. Field description of the soils are available but currently not in a computer file. Plans have been developed to encode the descriptions. The laboratory data include particle sire analysis, bulk density, cation-exchange capacity, base saturation, and chemical and mineralogy analysis (4). The data base is located at the Nebraska State Computer Center in Lincoln. Information about the data base and how to retrieve data from it can be obtained from the Head of the National Soil Survey Laboratory, USDA Soil Conservation Service, P.O. Box 82502, Lincoln, NE 68501.
  - Soil Engineering Test Data Base. This data base contains engineering

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combination of properties. It lists the series together with their extent for various geographic areas as selected. The system "as developed jointly by the U.S. Army Construction Engineering Research Laboratory and USDA, SCS and is located at the University of Illinois, Urbana, IL. Information regarding the data base and how to retrieve information from it can be obtained from the Branch Chief, Data Base Management Branch, Information Resources Management Division, USDA, Soil Conservation Service, P.O. Box 2890, Washington, DC 20013.

Soil Geographic Data Bases. The SCS has established soil geographic data bases as part of their NCSS responsibility. The soil geographic data bases will be the key to establishing a nationally consistent geographic resource data base for SCS. In addition to providing an efficient computer assisted method for analyzing and displaying spatially-referenced soil data, an SCS objective is to assure maximum use of the data by providing public access via computer terminals and plotters at local agency offices. A brief status of each data base and its description follows:

- Soil Survey Geographic Data Base (SSURGO). This data base is a collection of separate nonintegrated soil survey area geographic data bases. It is used to assist farm and ranch conservation planning, and county and multicounty resource planning and management.

Standards and specifications for the soil maps to be digitized are those given in the SCS, National Soils Handbook (5) for soil survey maps. The standards and specifications for data to be digitized, accuracy, coordinate values, and magnetic tape requirements for the necessary data files are those given in the SCS, National Cartographic Manual (7) for line-segment and cell digitizing methods.

More than 600 survey areas have been digitized using the cellular method and over 50 areas have been or are in the process of being digitized using the line segment method.

- State Soil Association Geographic Data Base (STATSGO). This data base will comprise a collection of integrated state general soil maps. It will be used to assist in multicounty, state, and regional resource planning, management, and monitoring. The data base is in the planning state. Proposed standards and specifications for state soil association maps to be digitized are being reviewed by NCSS. Map sheets of the USGS 1:250,000 map series, are proposed as the map base. Standards and specifications for digitizing have been written.
- National Major Land Resource Area Geographic Data Base (NATSGO). This data base consists of the digitized 1:7,500,000 Major Land Resource Area (MLRA) map. (9) This data base is used to assist in regional and national resource planning, management and monitoring, and program evaluation and analyses.

The components of each map unit on the MLRA map are being determined from data collected for the 1982 National Resource Inventory (3) Soil map units according to the NRI have been assigned a MLRA and can be expanded statistically to provide map unit composition. Soil interpretation record numbers have been assigned each component so the component can be linked

with base		soil p	property	y attr	ibutes	in the	Soil :	Interpr	etation	• Record	data
Soil	Data	Base	Manager	ment.	SCS is	develo	ping a	a Boil	data <b>b</b>	Ase	
						_					
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# SOIL RESOURCE DATA BASE DEVELOPMENT G. L. Decker and K.K. Young 1/

## Introduction:

The National Cooperative Soil Survey (NCSS) coordinates a joint effort to map roils, collect data, interpret the ups and data, and promote their use. The roil survey program la carried out by field and laboratory investigations. The field inveatigations are usually of counties, parts of counties, or similar areas. When they are completed, the results are published in a soil survey. The published • urvay contains soil maps and a text that describes. classifies. and interprets the soils. The laboratory investigations • ra site specific. They provide basic data to help field investigators describe. classify, and interpret the • oila. The basic data are also used to show the relationships between roil propertiae and soil performance.

The goals of the NCSS are to make soil surveys that inventory the Nation's soil resources, record their locations. predict their performance under defined use and management. enable the transfer of soil information from one location to another. and contribute to the knowledge and understanding of our land resources. One goal of the SCS is to make the data more available to the users. A workshop was held la April of 1982 to identify data problems, data accessibility, and future data and user needs. The vorkshop participants also developed short— and long-range plans for designing and implementing an integrated, user-accessible natural resource data base.

# Laboratory Data:

Data on the physical, chemical, engineering, and mineralogical properties of many soil series are stored in computara at the National Soil Survey Laboratory (NSSL) in Lincoln. Nebraska, and at nearly all the cooperating state universities. The coding • yatem for there data was developed by NCSS and published as the "Pedon Coding System for the NCSS."

The laboratory data base at the NSSL contains laboratory physical and chemical data for more than 10,000 soils and engineering teat data for more than 1,200 soils. The physical and chemical data are available on computer tape from the NSSL. The engineering teat data are available to USDA users from the USDA Washington Computing Center (WCC).

SCS recently completed procedures to input and retrieve the engineering test data from the WCC via remote job entry (RJE) equipment.

SCS is developing procedures to (1) index the NSSL data currently on the computer, (2) input the index data for other SCS and university laboratory data not in the NSSL system. and (3) uae a micro-computer to input the field pedon description data associated vlth the laboratory data.

Short-range plans are to select physical, chemical, and mineralogical data for typical or benchmark soils. The index and field descriptions will also be included. The data will be stored on a commercial computer for public use and on a USDA computer for USDA use.

L/National Leader, Soils Data Base Development; Cartography & Geographic Information Systems Dlvlslon and Soil Information Systems Specialist, Soils Division, SCS, Washington, D.C.

# Soil Descriptions:

Site specific data for NCSS official strict descriptions and toil turvey area series descriptions art stored by word proctting equipment and are printed out to provide hard copy.

About 2.000 official series descriptions and an undetermined number of soil survey area descriptions have been stored using word processort at the SCS national technical centers (NTC's) and state offices.

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A subset of the soil interpretations data base for the state of Colorado is also available to USDA users in an interactive mode using the System 2000 data base management system (DBMS) at the PCCC. Many kinds of user-specified table outputs Are possible using the DBMS natural language.

In August 1983, procedures will be completed to (1) reformat the • oil interpretations data so that they are more compatible for data processing, (2) load the data for the whole U.S. into the System 2000 DBMS at the FCCC. and (3) enhance the retrieval of data from the CERL computer.

Procedures are being developed to (1) merge the soil interpretations data base with the map unit use data base on the CERL computer and (2) provide search capability for the merged CERL data base.

Short-range plans are to (1) develop **software** to **retrieve** standard reports from the **DBMS** at the PCCC and (2) develop procedures for more efficient updating of the DBMS at **the PCCC**.

# Hap Unit Use File:

The map unituse date base contains data for more than 1,600 roil survey areas. Soil mapping has been completed in these areas and meets the current needs of the local people who use the information. The data base includes the name and symbol of each map unit, the counties and major land resource areas where each is mapped, the acreage of each unit, the percent composition of multi-tame units, and a soil Interpretation record number and appropriate phase data that will be used to link the map units to the roil interpretations record data base.

The map unit data base Is located at the Iova State University (ISU) Computing Center, Ames, Iowa. The data are available on tape upon rtquttt from the SCS and tabular output is available to SCS users via RJE equipment.

A subset of the data base for the state of Colorado is **evallable** to USDA users in an interactive mode using **the System** 2000 **DBMS** at the FCCC. This DBMS can be linked to other **System** 2000 **DBMS**'s such as the Colorado soil interpretations DBMS. **Many** kinds of user-specified tabular outputs are possible using the DBMS natural language.

Between October 1982 and April 1983. SCS completed procedures to (1) transmit the map unit data from state office t othe ISU computer via RJE; (2) check. by ISU computer for internal data consistency and for compatibility with the interpretations data base, and transmit error messages back to the SCS state office for evaluation and correction; (3) store the corrected data and have them accessible for retrieval in Avariety of formats; and (4) integrate the map unit data with interpretations data to retrieve soil interpretations tables for survey areas.

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Short-range plans are to (1) enhance the map unit utt-toll interprecations data bttt search capability at the CERL computer; (2) lotd the date for the O.S. into the System 2000 DBMS at the PCCC, and (3) develop procedurt to better link all the Syttem 2000 DBMS'6 at the PCCC.

# Future Plans:

Long-range plans areto (1) develop procedures to aid SCS field offices in filling data voids and correcting errors in the data bases, (2) document end define the soil data items and develop a data dictionary for 611 the toil data collected, (3) document relationships between toil dtrt tributts, (4) identify and document

Most of these systems discussed in Reybold's and Decker's papers would be accessible through a microcomputer equipped with a modem and a communication program. The advantage Of using 6 micro is that data can be saved to dick and retrieved at a later time (it could not be manipulated as it was from the source program but modifications could be made). It could be reformatted and used in reports, etc. 35 the user needs it.

The use of aGIS probably would require 6 special graphics terminal. This terminal would be capable of producing high resolution color graphics. As micros become more sophisticated they could be adapted to this type of information display. Currently, for example, there are at least five manufacturers that produce high resolution graphics plug in boards (640 x 400 minimum) for IBM type machines.

There have been several proposals (NHQ among others) to load a S.O. minicomputer with the necessary data bases for F.O. and S.O. access. The main problem I visualize with this scheme is storage space. The dats bases we will be using are very large and I don't think it is very feasible to expect a mini to be able to handle that much information and be able to manipulate it. If the technology changes fast enough (it seems to be doing that) a mini might have the same processing power as a current main frame and then this idea becomes plausible.

Determine potential for integrating existing data bases for making available relevant, valid and reliable soil and natural resource data from these data bases.

Ar integrated system using a CRAY computer and laser disk storage medium could provide us the information we need at an unbelievable speed. It would take a large number of users to begin to slow the system down; many more than is now the case.

On a more realistic bases, we have the capability to access many of these data bases right now through the Harris terminal and field micros and terminals. The information is fairly raw but for many purpose6 it is sufficient. Given the specific coal of intergrsting existing data bases into a workable, user friendly environment; the proper people could pull this off and, I think, in a reasonable period of time.

The bottom line is that there are a large number of data bases already ir place containing the information we need. The technology is available to use these data bases. The only remaining problem is to create an integrated data retrieval system that would be centrally located. This is a programing function and, at I see it, well within our reach. All it takes is a

The following paper was developed by Jim Stone, BLM; Gordon Warrington, F.S.; Larry Munn, University of Wyoming; David Anderson, SCS, and Tom Priest, BCS.

# Responses to Charges for Committee 7 "Coordination of Data Base Systems"

#### Data Base Capabilities

Most soil data bases currently exist as paper reports and In files. The focus of this charge is to identify the capabilities which a computerized soil data management system should have in order to serve agencies and clientele who provide and/or use National Cooperative Soil Survey (NCSS) data. These data bases can be used to maintain information about relatively permanent soil and land attributes.

Soil and soil related data bases are used by Forest Service and Bureau of Land Management watershed specialists to develop land management information for use in planning natural resource allocations. implementing projects, and monitoring management practices. The Soil Conservation Service uses similar data bases when advising their clients on soil management alternatives and planning conservation projects. University scientists use these data bases to plan research projects so that they can take advantage of existing information, reduce the time needed to conduct research, and increase the scope of projects.

There are two general kinds of computerized data bases, tabular and digital, which can be used to store soils data. A tabular data set consists of attribute listings such as would be used in a soil pedon description. A digital data set is used to store spatial data about the location of polygon lines delineating map units.

A possible scenario for using an integrated, computerized information system in land management activities would be to characterize the environmental condition under existing management and to develop alternative management practices for achieving a particular land management goal. Because some important land attributes change rapidly over short time periods (e.g., amount of ground cover), a current inventory of temporal items may be needed to supplement a permanent soils data base. After a preferred alternative is selected, data bases are used during the development of plans for implementing the project.

In the course of developing possible management alternatives and project designs data will be needed from several sources. For example, describing an annual soil moisture regime of a soil will require data about local climate, soil water holding characteristics, and vegetative cover conditions. These data are most likely to be stored thematically in separate data bases. therefore, an integrated data management system must facilitate the retrieval of data from several different data bases.

In order to accommodate a diverse set of management needs, data bases need to have the following capabilities:

1. Be available for interactive access so that a person can querry data sets directly and Immediately from a computer terminal.

- 2. Have a querry language that will support ad-hoc searches of the data bases. An example of en ad hoc search might be a request for the number of acres of a particular kind of soil in a given geographic area.
- 3. Have provisions for identifying the geographic location of individual soils data sets stored in the data base.
- 4. Have attributes which will facilitate the combining of tabular and digital themes from separate data bases.
- 5. Have attributes that will facilitate the Integration of separate data bases into an overall data management system
- 6. Store data in formats which are compatible with the requirements of statistical and mathematical analytical tools.
- 7. Operating procedures and supporting software must be user friendly. One example is to create menus of data processing alternatives that will appear on a users terminal. The desired processing steps are selected from the menu by the user.
- 8. Be supported by a comprehensive data dictionary.

#### Existing Data Bases and Integration of Data Bases

Gathering of new resource data it increasingly expensive and It is therefore important that existing data bases be identified, automated, and made available for utilization by interested agencies. Because land managers are seldom interested in fnformation from only one data base, or one type of resource data, methods must be identified, or developed if they do not already exist, to integrate \$011 resource data bases with other types of data bases, such as land ownership, climate, vegetation, wildlife distribution, geology, etc.

Acceptance of soil data bases as a useful tool by managers is dependent upon the successful meshing of soils Information with information from other resource data bases, technical guidelines, legal constraints, productive potentials. and other components of the management equation.

As a first step in identifying existing data bases, we recommend that the committee develop a questionnaire to be sent to member agencies of the NCSS and others who might have data bases of interest to resource managers. A working group would be identified by the committee to send out the questionnaires and to compile responses. A sample listing of resource data bases (1979 vintage) provided by Gordon Uarrington is attached as an example of existing data bases and data processing software.

As a second charge, the working group would compile a list of available software in use by NCSS cooperating agencies or others which have potential value in resource management. This list would include a brief description of program capabilities and agencies or personnel who have used.

In terms of data base integration, the committee should be made aware of the Colorado Soil Resource Information System (SRI) and the Computer Assisted Resource Planning Model (CARPM) as examples of a useful working system A compilation should be made of the current status of other exfsting data bases. Information to be collected should include who can access them, who can input data, and what is the computer capability required for access, etc.

A study should be made by a (second) working group to identify existing Integration schemes, problems apparent in integrating existing data bases. and a suggested format for establishing new data bases in readily accessible and integrateable format. Examples of successful integration of data from multiple data bases should be provided to committee members for their use in demonstrating capabilities to managers in thefr agencies.

A final consideration should be the

- (a) First, there Is a need to school managers and resource specialists alike in the general capabilities of automated information systems, the kind of products that are possible, and how these products relate to actual problem solving and practical decision making.
- (b) For a smaller and probably less diverse group, training is needed in the actual operation, maintenance, and management of the data base as well as integration with related data bases, Particularly Important is the relative reliability of the different types of data,
- (c) In addition, training could be incorporated into college-level curricula to develop a pool of informed potential users and practitioners. Emphasis should be on the practical application as well as the more technical aspects of data base operation.

#### 3. Administrative Responsibilities

Access to a data base along with an ongoing management of a system are &&important concerns. For example, who will have access to the data. Yhat will be the nature and extent of accessibility by non-Federal or perhaps non-NCSS users? Who can update. revise, and/or add new types of information? Yhat level of security will be needed to prevent degradation of the data base through misuse? What sort of feedback mechanism should be employed to assure that any problems encountered by users can be efficiently remedied?

#### 4. Research and Development

Research is needed into ways of managing information in order to improve the collection, management, integration, and use of natural resource data and information. Areas of research needs are: a systems analysis of current data collection and management processes; developing methods and tools for NCSS cooperators to use for assessing and processing the data; and developing a framework for relating soils data to land management uses of information in setting goals and implementing practices.

#### Future Data Management Needs

'A discussion of data base capabilities and needs requires a brief discussion about the present and potential uses of natural resources data bases. These present and perceived uses will dictate capabilities and requirements of our data bases. These needs are:

1. Applying soils and other resource data to an integrated computer assisted resources planning process.

The resource planning process involves the assimilation of three major kinds of information. These are: (1) natural resource data collected and stored in data bases, such as soil survey reports and range site description, (2) technical application Information or 'how-to-do" information which resides in technical guides planning manuals and handbooks; and (3) data and information collected as a part of the on-site planning process. The latter kind of information, examples of which are seasonal crop management information, are of such a temperal nature it is seldom stored in a data base.

In the future it will be important that data bases be organized to support this planning process in such a way as to make the automation of the planning process possible.

2. A repository for newly collected data and a medium for updating or editing existing data.

This would facilitate the addition of new kinds of data and maintenance of existing data.

3. The ability to ask the "what if" kinds of questions.

For example, what would be the economic impact of increasing the carrying capacity of rangeland in a county by one condition class? To answer this question requires the integration of both soil and land use data. The capability to ask the "what if" questions will provide us with new insights on data relationships and allow us to increase our capability to predict the outcome of proposed land use changes.

4. Correlation of environmental factors.

Data bases can be used to understand and document interactions between environmental processes. This will dictate that various resource data bases be compatable.

5. Documentation of charges in environmental conditions.

Both long and short ten.

The following attached chart gives a rough overview of how the ADP program could work in a state if all soil survey field offices had micro computers and the state office or equivalent had digitizing capabilities. These systems would be compatible to the lacktriangle econd attached chart of the national soil data base or to the third chart's illustrating plans for down loading of main frame data to micros.

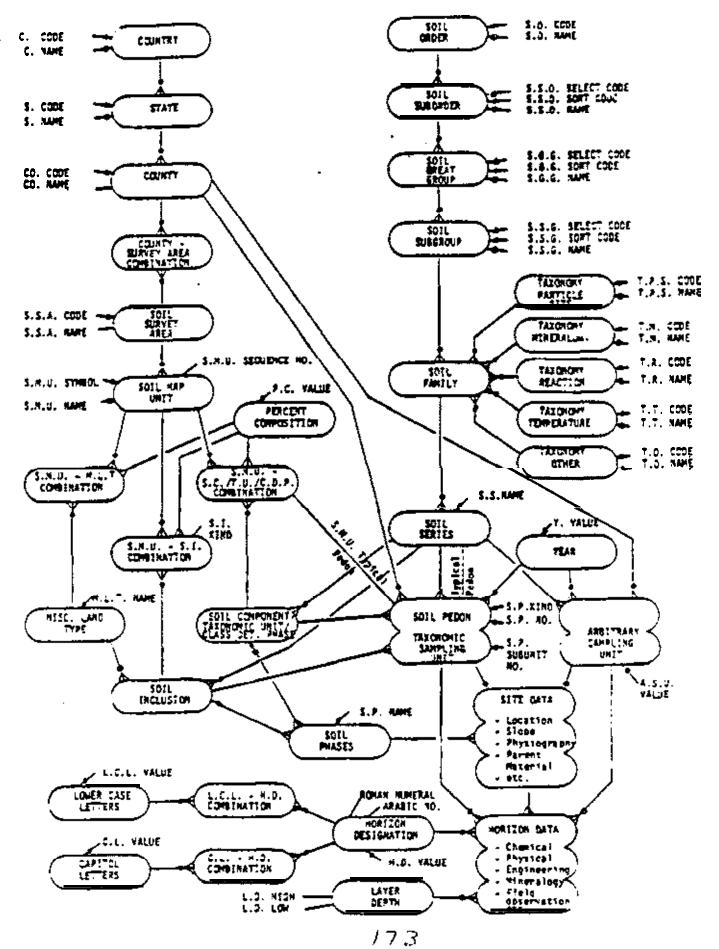
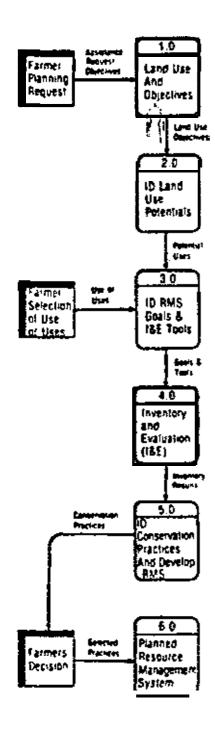
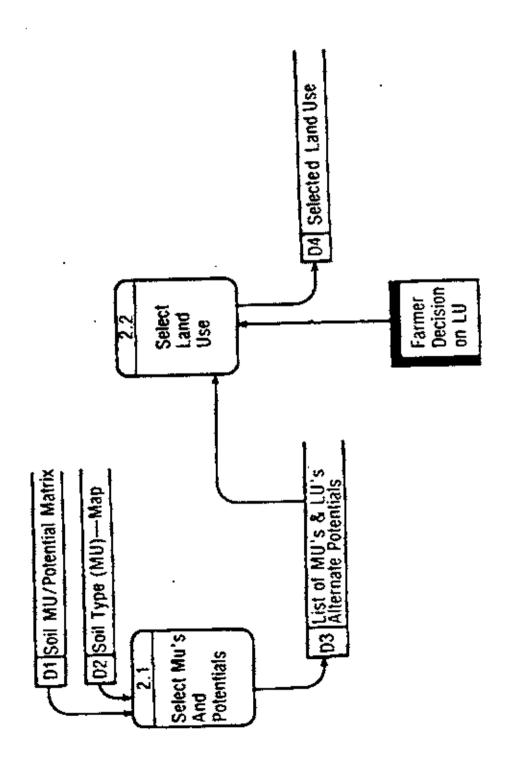
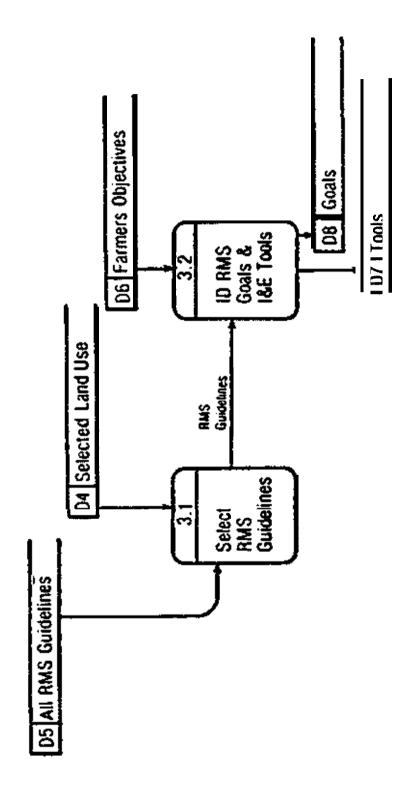


figure 5.-- Abbreviated Logical Data Structure for some soils rate relationships. Included are the Soil Series - Soil Texonomy relationships, the soil map unit-quographic location relationships. She soil map unit-component relationships, and the soil median relationships.

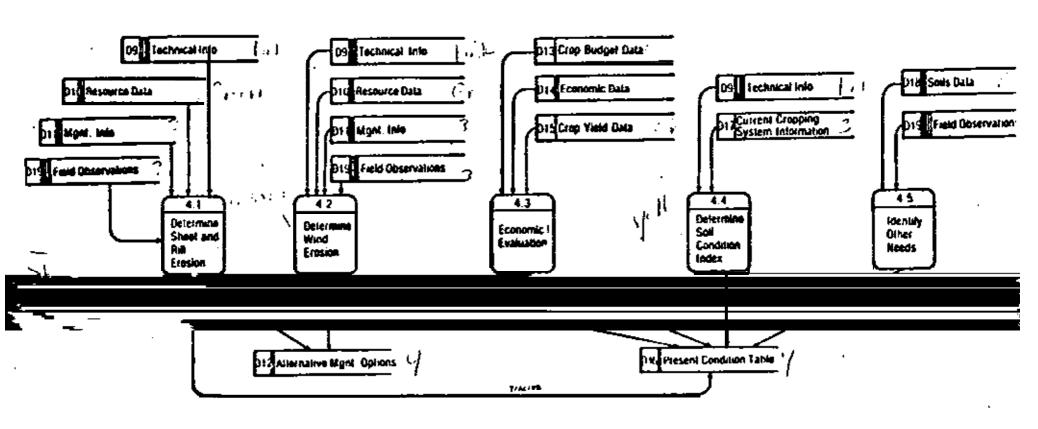
#### IESOURCEMANAGEMENTSYSTEM DECISION PROCESS



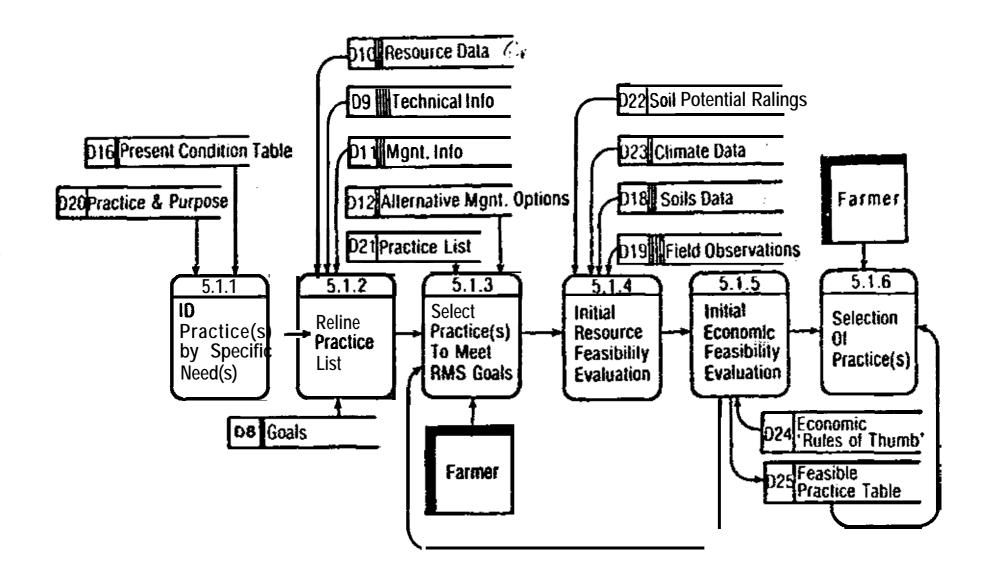


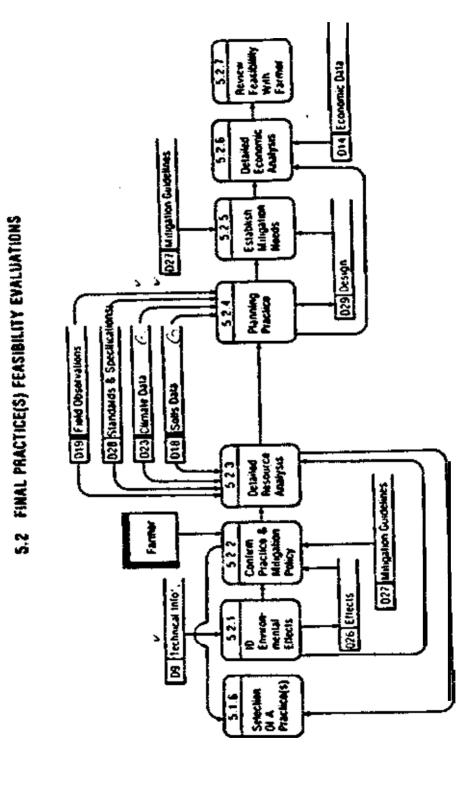


# 4. O INVENTORY AND EVALUATION (ILL)



# 5.1 INITIAL PRACTICE SELECTIONS





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# REPORT OF SOIL TAXONOMY COMMITTEE February 1982 to Nay 1983

At our last planning conference, you voted to make the Western Regional Soil Taxonomy Committee a permanent committee of this conference. You further charged this committee with providing a report to this conference. The following provides a brief report on the activities of this committee since our last conference. Also included are some recent activities in Soil Taxonomy which should be of some interest to each of you.

#### COMMITTEE ACTIVITIES

- 1.— Ike Ikawa, University of Hawaii, and Earl Alexander, Forest Service, California were appointed to the committee during our "off year".
- 2.-LeRoy Daugherty, New Mexico State University, and Phil Derr, SCS, Wyoming will be going off the committee at this conference.
- 3.— Approximately 10 pieces of correspondence were shared with the committee. These were primarily proposed amendments to Soil Taxonomy or circulars from the International Soil Taxonomy Committees (ICOMS).
- 4.— At the request of a majority of the committee members responding, we have established a special subcommittee under the chairmanship of Eddie Spencer. SCS WNTC. Portland to develop criteria for Cryic Aridisols. Ed will be appointing this committee in the very near future. If you are interested in working on this committee (and I mear WORKING) please let Ed know as soon as you get back home.
- 5.- It has been proposed that we also establish a special subcommittee to work on the proposal to recognize the subgroup of Aquic Furitropepts. We will wait until more comments are in from the committee before we procede with this suggestion.

#### OTHER ITEMS OF INTEREST IN SOIL TAXONOMY

- 1.— The KEYS TO SOIL TAXONOMY have been published by SMSS, and have been distributed to ell Soil Scientists participating in the National Cooperative Soil Survey. A?: amendments to Soil Taxonomy approved to date are included in this publication.
- 2.- NATIONAL SOIL TAXONOMY HANDROOK ISSUE NO. 3, August 23, 1983 provides a mechanism for making and processing proposals to amend Soil Taxonomy.
- 3.- For a number of reasons, but primarily because the position of National Leader for Soil Taxonomy has been vacant for so long over the past years, there is a large backlog of proposals to amend Soil Taxonomy in the SCS National Headquarters. John Witty will be reporting for duty in this position sometime in July. It is hoped that John will be given the time needed to concentrate on trying to unplug this backlog.
- 4.- Soil Taxonomy is now on the computer at Cornell University. Plans are to run all new proposals to amend Soil Taxonomy through this

program to determine which parts of Soil Taxonomy will he impacted by the proposal.

5.— The final report and proposals from the International Committee on Low Activity Clays (ICOMIAC) are scheduled to be distributed for field testing very shortly. We will have approximately one year to test these proposals and return comments before they are finalized and made a part of Soil Taxonomy.

RICEARL K. KOVER. Chairman

Western Regional Soil Taxonomy Committee

Attached are guidelines for testing proposals to amend <u>Soil Taxonomy</u>. This was developed by Richard **Fenwick** to be sent out with the proposed Key to Soil Orders and Suborders and great group keys of **Alfisols** and **Ultisols**.

Any comments you have regarding these guidelines would be appreciated.

#### Attachment I

#### Guidelines for Testing Proposals to Amend Soil Taxonomy

#### Introduction

There are eight international committees (ICOMs) working to refine Soil
Taxonomy. Most of their work is accomplished through correspondence.

International Soil Classification Workshops have been organized for some of the ICOMs to serve as a forum for discussions among committee members. The work of the ICOMs has been long and tedious and their conclusions and recommendations, which are now being distributed for testing, have been extensively debated.

We are still open to new proposals at this stage of testing the proposals of ICOMs; however, we prefer that you restrict yourself to examining the validity of the proposal. The guidelines provided here are designed to enable you to test these proposals and make recommendations for their incorporation into Soil Taxonomy.

#### Amending Soil Taxonomy

A small change in one part may **affect** other parts **of** the system. In making the draft proposal, we have attempted to make all **of** the necessary changes throughout the system. **However, we may** have missed a **few.** 

TEST No. 1. Ensure that necessary changes have been made in the relevant parts of Soil Taxonomy.

When class limits are changed, the possibility is that some soils may not have a place in the system if classes are not mutually exclusive.

TEST No. 2. Ensure that all soils known to you have a place in the system.

Chapter 2 in Soil Taxonomy gives the principles **for** selecting **differentiae** and the attributes desired in the classes. Please read this carefully to ensure that these principles have not been violated.

 $TEST\ No.\ 3.$  Ensure that the fundamental concepts and principles of Soil Taxonomy are not violated.

The purpose of amending a system is that as a consequence of the change, the system is significantly improved. 'Our goal has been a blending of many views to arrive at an approximation of a classification that seems as reasonable as we can hope to reach with our present knowledge." This statement from Soil Taxonomy (page 11) continues to apply. The follo`asse follo`asse

- TEST No. 5. Ensure that the **new taxa** are concepts of real bodies and that the proposal provides **taxa** for all soils in a landscape.
- TEST No. 6. **Ensure** that the modifications have resulted in a significant improvement in the interpretative capability of the system.

#### Testing for ICOMLAC Proposal

The proposal of the International Committee on Classification of Soils of
Low Activity Clays (ICOMLAC) is the result of about eight years work under
the leadership of Dr. Frank Moormann of the University of Utrecht,

Nederland. More than 100 soil scientists from all over the world have

contributed to produce this draft poposal. We would appreciate your comments
on the proposal.

Testing a proposal is difficult, and it is for this reason these guidelines are provided. Although there are eight independent ICOMs, we have tried to coordinate their activities so that proposals of one do not conflict with that of the other. In this case, ICOMLAC proposals affect the Oxisols (ICOMOX), but the Chairmen of these two ICOMs have tried to merge their ideas. A tentative key to Orders is included to show the position of the LAC soils in relation to others, particularly the Oxisols.

#### Specific Items to test and/or check

- a. Summary of properties (pages 9-10).
- b. Orders Proposed key to orders.
- c. Suborders There are no changes in the definition of the suborders.
- d. Great groups and particularly the proposed new great groups In each suborder, test the keying out of the great groups.
- e. Subgroups check the usefulness of each subgroup, and if necessary, suggest others.
- f. Color requirements for **Rhodic** great groups have been changed.

#### Procedure for Testing

Existing soil maps. soil survey reports and soil characterizaton data are the tools for testing. Suggested steps to testing are:

- 1. Classify your soils according to Soil Taxonomy (1975).
- 2. Classify your soils according to the new proposal.

- 3. Make a table showing the old and new classifications and giving series names or pedon identification. (Submit this with your report.)
- 4. Determine if the new classification (1f changed) is an improvement.

  You need to base the decision on your experience. In your report,
  we would like to know both if you approve or disapprove of the
  changes, and in either instance, the reason why.
- 5. If you propose alternatives,
  - a. make detailed justification,
  - b. provide pedon data.
  - **c.** provide any other information, particularly management information.
- 6. Submit your report to the Director of **Soil** Survey Division.

## PROPOSED SITE CORRELATION PROCEDURES

By National Soils Range Team

#### NATIONAL SOIL-RANGE TEAM

#### Proposed

#### site Correlation Procedures

Currently there are no formal site correlation procedures, except those broadly defined in section 308.4 of the Uational Range Handbook (NRH), and none evident in the Uational Forestry Manual (NFM). The purpose for this proposed "Site Correlation Procedures" is to establish a degree of compatibility with current soil correlation standards as set forth in the Uational Soil Handbook (NSH). A formal procedure is needed for both the Uational Range Handbook and the Uational Forestry Manual. A site correlation procedure will provide a methodology for paralleling site correlation in an informal manner with soil correlation from field work to final formal correlation. (See NSH section 602.00-4)

The term "to correlate a site" will be used in the context of the dictionary definition, to "establish in orderly connection." The term "correlation" will be used in the context of the physiological definition, whereby the site forming factors have an interdependence and a reciprocal relationship to each other. Generally, for a site to be correlated it must have completed Parts A (physical and biological features for a site) and B (interpretations for a site) before the site can be fully distinguished from associated sites.

The term "site" includes range, woodland, grazable woodland. and ecological sites. The site concept has a similar relationship to the soil series concept, in that a site can be correlated in a similar manner as a soil series. A soil series, for example, is a concept of a soil that is influenced by the five soil forming factors. Soil is a function of parent material + relief + climate + biota + time in place. Soil is classified upon the kinds of properties that make it similar or different from other soils. The soils are compared and correlated on the basis of the documentation, amount of this soil within a survey area, and its interpretive value for use and management.

A site, similarly, is a function of parent material + soil + topography and relief + climate + biota + time in place. The site description emphasizes the kind and amount of vegetation produced as influenced by specific soil properties, as well as the other site-forming factors. Sites can also be compared based on their similarities or differences. To correlate sites, sufficient documentation is required for all the site-forming factors and their interpretive values for use and management.

#### For Test Purposes by the NSRT:

NRH section 302.8(b) Correlating range sites, and NFM section 537.31 Field operations in soil-woodland correlations are supplemented as follows:

#### A. Responsibility

1. The Director, Ecological Sciences Staff, National Office, SCS.

through the National Technical Centers (NTC's) has the responsibility

for the correlation and establishment of sites.

The NTC Director will be responsible for correlating sites within his region and will maintain a file of all correlated sites by using a numbering system and retaining copies of all correlated site descriptions.

- 2. State Conservationists will be responsible for maintaining a record of all sites within their state according to their status and for proposing sites to the UTC. They will also be responsible for correlating all sites within their state. When a site occurs in more than one state, the NTC Director will designate the state responsible for maintaining and updating the site.
- 3. Field personnel will be responsible for collecting the necessary documentation for each site used and will propose draft descriptions as needed for further consideration and approval by the SCS State Range Conservationist.

#### B. Procedures

- Internal consistency site forming factors should be checked to insure compatability within each factor and between individual factors.
  - a. Each individual factor should portray the narrowest range of characteristics feasible that accurately describes the site.

    For example, does a site occur on all aspects in mountainous areas between elevations of 5200' to 6800' and on south aspects from 6500' to 8200'?

Exceptions that occur due to unique combinations of factors rather than the perceived normal should not be included within the described range of characteristics but can be discussed in the narrative.

b. **All** combinations of factors must be checked for **compatability** between the range of characteristics described for each individual factor. A **common** example of inconsistency is between the soil classification criteria and the climatic factors described. Other apparent inconsistencies often occur between plant species listed and the soil pr<498 ?Ÿnd24 d anur b.89106

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- A 20% (absolute) change in composition air dry weight 2) between any two species in the potential plant community, or equivalent change in tree density or cover for woodland or forest sites.
- 3) A difference in average annual herbaceous production of:

50% **2** 200-500 #/Acre

30% @ 500-1000 #/Acre

20% @ 1000 #/Acre

or an absolute difference of 20 in site index.

A 20% difference in management uses or limitations based on 4) any one of the site factors.

The above criteria are merely guidelines for initiating comparison during the correlation process and would not necessitate site differentiation or The breaks between sites may be finer or broader than the above combination. guidelines, if supported by rationale and the differences can be readily and consistently distinguished by the site factors listed in the respective Notable exceptions might include sites where one species makes descriptions. up more than 70% of the production or the occurrence of highly site-specific. minor indicator species.

#### 3. Documentation required

- Acreage requirement a.
  - 1) A minimum of 200 acres must be identified to propose a site.
  - 2) A minimum of 2000 acres must be mapped to become an established site.
  - 3) An exception might be for highly unique or important sites, such as riparian areas.

- b. Physiogrsphic factors Copies of field sheets and any supporting maps (geology, topographic, slope, etc.).
- c. Climate Date from nearest representative weather station(s).
  research or field study.
- d. Soils Copies of SCS official series and SOI-5's and/or 232's used to describe the range of soil properties typifying the known range of the site.

#### e. Vegetation

- At least one SCS Range 417, or Range Condition Worksheet or equivalent woodland data, should be completed per soil tsxanomic unit listed in each site description with a minimum of three write-ups per soil family listed.
  If range documentation cannot be provided for each soil correlated to the site, soils without such documentation must be designated.
- 2) A plant association table (NRH Exhibit 302.7A, or equivalent display) for each site.
- f. Wildlife Historical accounts, special studies, field observations.
- g. General Field notes, photographs, etc.

#### c. Records of Site Descriptions

- Site description files containing complete site descriptions will be maintained by <u>Proposed</u>, <u>Established</u> and <u>Inactive</u> status.
  - a. <u>Proposed</u> site descriptions will be maintained by the responsible State Offices and NTC's on any color psper except blue.

b.	Estal	plished sits descriptions will be maintained by the					
	respo	onsible State Offices and NTC's on blue Paper. state					
	Offic	e6 will maintain supporting documentation of the site					
	desc	riptions.					
c.	<u>Inactive</u> site descriptions will be maintained by responsible						
	NTC'	s.					
Site	e record card files will be maintained by the responsible NTC for						
tracl	king	site status and actions.					
a.	Cont	ents will include:					
	1)	Site number					
	2)	Name					
	3)	Responsible state					
	4)	Status in the following format:					
		Author State Approval NTC Approval Date					
		Proposed					
		Established					
		Revised					
		Inactive					
		Combined with <u>site # Name</u>					

b. All users will be notified of any change in status upon approval by NTC.

dropped because:

2.

WRH Section 302.9 Range Site Descriptions end NRH Section 402.2 Woodland Understory Descriptions and Interpretations. end NFM Section 537.23 Group, are supplemented to include the following Outline end Guide for Site Descriptions.

Rev. 4-S- 84

# Site Correlation

#### Checklist

۱.	Name of Area(s)			
	· \ /	(County(s)	State(s)	MLRA(s))
<b>a</b>	Town of Comments			
5.	Type of Survey(s)	(level of detail -	soil and vegetation	)
3.	Participant5			
١.	Site Content (Nun	nber reviewed		ے
	a. Range of cl	naracteristics for sit	te forming factors	
	Sites with	deficiencies:		

b. Consistency and compatability between factors Sites with deficiencies: 5. List associated sites to be compared during correlation and their status (proposed (P), established (E)). (ref. Item 2. pp. 4, Proposed Site **Correlation Procedures)** 6. List sites correlated and state responsible. 7. List sites dropped or combined. 8. Documentation (note deficiencies). Acreage requirements a.

	c.	Climate
	a.	Soils (series descriptions, Form 5'8,232's)
	e.	vegetation (417's, etc. and plant association tables)
	f.	Wildlife
	g.	General (field notes, photographs, etc.)
9.	Reco	mmended actions
10.	Site	record card file completed(date)
Date	e	
	natur	

Field sheets, maps, etc.

b.

### NE REPORT

# Northeast Soil Survey Activities

by

# Dr. Edward J. Ciolkos $z^{1/2}$

Greetings from the Northeast. My presence at your meeting is an extension of a regional conference representative exchange we started two years ago. At that time we (in the Northeast) sent a representative to the Northcentral, Southern and Western Cooperative Soil Survey conferences, and had a representative from the Southern (Dave Lietzke - Univ. of Tenn.) and the Northcentral (Ivan Jansen - Univ. of Ill.) regions attend our conference in Ithaca, New York. This year we will have a representative at the Northcentral (Jim Baker - VPI and State Univ.) and at your conference (joint Southern and Western), and we have been notified that Neil Smeck (Northcentral-Ohio State Univ.) and LeRoy Daugherty (Western-New Mexico State Univ.) will be joining us June 10-15 in Amherst, Massachusetts for our conference.

At our last conference in Ithaca the membership approved the establishment of a "Northeast Cooperative Soil Survey Newsletter," with the conference steering committee acting as its editorial board. The conference also determined that the cost of the newsletter would be born by a conference registration fee and the newsletter would be put out at least once a year. The newsletter is being distributed in the Northeast and on a limited basis in the other regions.

Also at our last conference it was suggested that we need a better dialogue with the Northeast Experimental Stations. As a result of this discussion a Northeast Experiment Station Regional Committee on Soil Survey (NEC-50) has been formed. This committee will meet annually and every other year it will meet at the Northeast Cooperative Soil Survey Conference. The committee presently is compiling a soil survey research needs list for the NE, and a listing of soil pedon data for the NE. In addition under the auspices of the NEC-50 committee a Northeast regional graduate student soils field trip has been established. The field trip will be an annual summer trip which will cycle from the northern to the southern part of the region every other year.

<sup>202</sup> 

<sup>1/</sup>Professor of Soil Genesis and Morphology, Agronomy Department, The Pennsylvania State University, University Park, PA 15802.

Our conference this year in Anherst will have the following committees:

- 1) Regional Erosion-Productivity Studies, 2) Soil Survey Training Course,
- 3) Role of Soil Series in Taxonomy, and 4) Interpretations of the Northeast General Soils Map. In addition a large number of speakers and demonstrations will focus on the computerization of soil survey information.

Our General Soils Map and Bulletin for the Northeast have just been published and are on display in the back of the room. A manuscript derived from the data of our Northeast soil characterization study has been accepted by Soil Science for publication. Unfortunately, because of an apparent large backlog of manuscripts the paper will not be published until the second half of 1985.

Our conference is like yours, a part of the soil mapping activities of The Northeast is much different than your regions. Our 13 states the region. (CT. DE. ME. MD. MA, NH, NJ, NY, PA, RI, VT, VA, and W) encompass an area that is about 154,000,000 acres in size and it is about 7% of the land area of the 50 United States. Being somewhat smaller than your regions, our soil mapping is progressing rapidly. The Northeast is 73% mapped and about 50% of the mapping is published. We have five states (Maryland, Delaware. Connecticut, New Jersey and Rhode Island) and the District of Columbia in which the mapping is finished. One additional state is almost finished (Pennsylvania about 98% complete), and the remaining states vary from 82% (Massachusetts) to 44% (Maine) complete. Thus the soil survey in the Northeast is rapidly moving into an era of using soils information as opposed to gathering it (soil mapping). This offers many challenges for us today and in the future.

In closing, I would like to say again that my purpose here is to help open better communication between the Southern and Western and the Northeast regions. In particular, I would like to propose the following:

- I) We continue with an exchange of conference representatives in the future.
- 2) We explore the possibility of regional newsletters which could be exchanged from region to region.
- 3) We explore the possibility of joint regional conferences.

CONFERENCE PURPOSE, POLICIES & PROCEDURES

COLLEGE OF AGRICULTURE AND HOME ECONOMICS

DEPARTMENT OF CROP AND SOIL SCIENCES Box 3Q/Las Cruces, New Mexico 88003 Telephone (505) 646.3405

January 12, 1984



Mr. Richard W. Kover West National Technical Center 511N.W. Broadway Rm. 514. Portland, Oregon 97209

Dear Dick:

Please find below some comments on your draft of the "Purpose, Policy and Procedures" for the Western Regional Cooperative Soil Survey Conference.

- II. A. Positions should hold the membership, not individuals.
  - B. Couldn't those not permanent members be referred to as guests, not as associate members?
- III. A. I don't feel that all the officiers need to be from the host state. Possibly there should be just a standing committee for conference arrangements. This committee could be made up of the local NCSS representatives. If the entire conference (steering committee) committee is made up of representatives from just o;ne state, the conference may not always succeed. I feel the officiers (& steering committee) should be elected from the membership at large. If your suggested officier slate is used, you may not get invitations from states for meeting locations. Local arrangements are not the bulk of the conference work. Officiers should be individuals and not positions. If the elected officier is no longer in the region, his office shouldn't automatically pass to his successor. The steering committee should appoint a replacement. The co-chairman should be a vice chairman and advance into the chairmanship for the next conference. This would assure some continuity. Items such as #6 should be with a local arrangements committee. Items 4 and 10 are duplicate. If the co-chairman has no specific duties, he should be vice chairman.

Richard W. Kover Page 2 January 12, 1984

- B. Instead of members from host state, only the chairman of local arrangement committee should be on the steering committee. Other members not ex officio should be elected by the conference.
- C. Experiment Station advisor should be the Administrative Advisor of Experiment Station Representatives or a representative selected by the representatives.
- D. Chairmanship of committees should be selected by the Steering Committee (steering committee may request conference recommendations).
- G. I would recommend having a signup list for copies of conference proceedings. These signup lists could be circulated by each of the other three conferences.
- VI. I would recommend a 2/3 vote for changes. I would also recommend that only permanent members be allowed to vote on matters of "Purpose, policy and procedure". This could be accomplished by supplying official ballots by mail before the conference.

Since Gary Muckel is out of the country, I will be sending out the agenda for the May conference.

- Total N. Van

Associate Professor

#### WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE

# PURPOSE, POLICY AND PROCEDURES

# I. Purpose of the Conference

The purpose of the Western Regional Cooperative Soil Survey Conference is to bring together Western States representatives of the Nations1 Cooperative Soil Survey for discussion of technical and scientific questions. Through the actions of committees and conference discussions, experience is summarized and clarified for the benefit of all; new areas explores; procedures are synthesized; and ideas are exchanged and disseminated. The conference also functions as a clearing house for recommendations and proposals received from individual members and State conferences for transmittal to the National Cooperative Soil Survey Conference.

#### II. Membership

# A. Permanent Membership

Permanent members of the conference include those individuals or positions listed on the attached Permanent Membership List. Individuals or organizations may be added to the list as deemed necessary by the current Steering Committee. The list will include agency, name (where know") title, address and phone number.

# B. Associate Membership

Invitations may be extended to a number of other individuals to participate in a specific conference or conferences. Any soil scientist, technical specialist, or other individual of any local, state or federal agency or interest group whose participation will benefit particular objectives or projects of the conference may be invited to participate. Any permanent member of the conference may invite one additional participant. If a permanent member wishes to invite more than one guest (or associate member) the request should be cleared through the Chairman or Co-Chairman of the conference, or the Chairman of the Steering Committee. Names of all associate members of a specific conference should be sent to the conference chairman.

#### III. Officers

#### A. Chairman. Co-chairman and Secretary

A chairman, co-chairman and secretary of the conference are elected to serve for two-year terms. Elections are held during the biennial business meeting. Election of officers follows the selection of a place for the next meeting, and will be from the state hosting that meeting. Officers rotate among the agencies. This is, the chairman-elect must represent a different agency than the past chairman. Similarly, the co-chairman and secretary must be of different agencies than their predecessors.

1

Responsibilities of the chairman include the following (specific tasks maybe delegated to the co-chairman):

- 1. Planning and management of the biennial conference
- 2. Function as a member of the steering committee
- 3. Preside at the conference business meeting
- 4. Issue announcements and invitations to the conference
- 5. Organize the program of the conference, select presiding chairman for the various **sections**, write the program, and have copies of the program prepared *and* distributed.
- 6. Make necessary arrangements for lodging accommodations for conference members, for food functions, if any, for meeting rooms (including committee rooms), for a field trip. and for local transport for other official functions.
  - 7. Duplicate and distribute the Proceedings of the Conference.
  - 8. Provide for appropriate publicity for the conference.
  - 9. Arrange for guest speakers for the conference.
  - 10. Preside over the business meeting of the conference.

Responsibilities of the co-chairman include the following:

- I. Function as a member of the steering committee.
- 2. Act for the chairman in the chairman's absence or disability.
- 3. Assist the chairman in carrying out the chairman's responsibilities, and perform duties as assigned by the chairman.

Responsibilities of the Secretary include the following:

- 1. Maintain minutes of the conference business meetings and other conference meetings as assigned by the chairman.
- 2. Obtain copies of all committee reports and papers presented at the conference, and see that copies are made available to all conference members.
- 3. Compile the conference proceedings and assist the chairman in the duplication and distribution of the proceedings.

#### **B.** Steering Committee

A Steering Committee will be selected to assist in the planning and management of the biennial conference. The Steering committee consists of:

Principal Soil Correlator, Western States (permanent chairman)

The conference chairman

The conference co-chairman

The conference secretary

The conference past chairman

All other Permanent Members from the Host State

### Responsibilities of the Steering Committee:

- 1. Formulate committee charges as recommended by the conference.
- 2. Select committee chairman and committee members as recommended by the conference.
- 3. Review conference activities and develop an executive summary of conference recommendations.
- 4. Send applicable conference recommendations to the Steering Committee chairman of the National Cooperative Soil Survey Conference.
- 5. Send applicable **conference** recommendations to the soil survey leaders of appropriate agencies for consideration and possible implementation.

#### C. Advisors

Advisors to the conference are the State Conservationist of the host state, or as selected by the conference, and the Experiment Station Director from the host state, or as selected by the conference. A Forest Service Regional Forester and BLM State Director may also serve as advisors as requested by the conference.

# D. Committee Chairman

Each conference committee has a chairman. The chairman are either selected by the conference or are appointed by the Steering Committee.

#### IV. Meetings

#### A. Time of Meetings

The conference convenes every two years, in eve" numbered years. **Itis** held the second full week in February, unless a different date is agreed upon by a majority of conference members.

B. The conference will be held on a rotational basis throughout the region. Any permanent member may invite the conference to meet in

their state. The conference members at their biennial business meeting will note on which invitation to accept, or where to hold the meeting if no invitations are received. If no state offers to host the conference, and the conference does not vote to meet in a specific site the conference will be held in San Diego, California, and the conference members will elect a state to serve as host State to perform the functions discussed in these procedures.

#### V. committees

The conference will have both permanent standing committees and special committees.

- A. Most of the work of the conference is accomplished by duly constituted official committees.
- B. Each committee has a chairman. A secretary, or recorder, may be elected by the committee or appointed by the chairmans, if necessary. Committee chairmans are selected by the Steering Committee or are elected by the conference.
- C. The kinds of committees and their charges are determined by the Steering Committee, based on the recommendations of the conference. Committee members are appointed by the Steering Committee after first determining the interests of conference members. The Steering Committee will assure that there is a balance among states and among agencies or each committee that is no one state or agency will dominate any single committee.
- D. Each committee shall make an official report et the designated time et each biennial conference. Committee reports shall be duplicated and copies distributed as follows:
- 1. One copy to each permanent member (whether present or not) and to each participant in the conference.
- 2. One final copy to the Conference Secretary for inclusion in the conference proceedings. This copy will include all revisions approved by the conference.
- NOTE: Committee Chairmen are responsible for prompt submission of their reports to the Chairman of the Steering Committee who will duplicate and distribute the reports. This should be done prior to the holding of the conference.
- E. Most of the committee work will be, of necessity, conducted by correspondence between biennial conferences. Committee chairmen are responsible for initiating and carrying out this work.
- F. Permanent Standing Committees may be established by the conference. These committees will report to each biennial conference until such time **as** they are disbanded. Permanent Standing Committees are:

Western Regional Soil Taxonomy Committee

# G. Conference Proceedings

A proceedings will be developed for each biennial conference. It will be compiled by the conference secretary and reproduced and distributed by the conference chairman, with assistance from the Steering Committee Chairman.

Sufficient copies will be reproduced for distribution as follows:

One copy for each permanent member, whether in attendance or  $\ensuremath{\mathsf{not}}$  ,

One copy for each associate member in attendance at the conference.

Twenty copies for the Chairman of the Steering Committee of the National Cooperative Soil Survey Conference.

Twenty-five copies for the Steering **Committee** Chairman of the other three regional conferences.

#### VI. Amendments

Any part of this statement of purposes, policy, and procedures may be amended at any time by simple majority vote of the conference members present at a conference, or by a mail vote of the permanent members.

# MEMBERSHIP LIST

of the

Anchorage, Alaska 99504 Douglas S. Posse, Soil Conservation

USDA, P.O. Box 1019, Davis, California 95616
Thomas W. Priest, Soil Conservation

- 6. Idaho
- 7. Montana
- 8. New Mexico

P.O. Box 4850,

11. Utah Ferris **Allgood,** Soil Conservation Service, USDA, Federal Bldg. **Rm.** 4012, Salt Lake City, Utah 94138

12. Washington James **Carley,** Soil Conservation Service, USDA, U.S. Courthouse, **Rm.** 360, Spokane, Washington 99201

13. Wyoming George Hartman, Soil Conservation Service, USDA, P.O. Box 2440, Casper, Wyoming 82601

# II. University or Experiment Station Soil Survey Leaders:

1. Alaska Dr. **Chien Lu** Ping, Agricultural Experiment Station, University of Alaska, P.O. Box AE. Palmer, Alaska 99645

2. Arizona Dr. D. M. Hendricks, Dept. of Agric. Chemistry 6 Soils, Univ. of Arizona, Tucson, Arizona 85721

3. California Dr. Gordon Huntington. Dept. of Land, Air and Water Resources, Univ. of California, Davis, California 95616

4. Colorado

Dr. R. B. Heil, Agronomy Dept., Colorado
State University, Fort Collins, Colorado
80521

5. Hawaii Dr. H. **Ikawa**, Dept. of Agronomy and Soil Science, Univ. of Hawaii, Honolulu, Hawaii 96822

6. Idaho Dr. M. A. Fosberg, Dept. of Biochemistry & Soils, univ. of Idaho, Moscow, Idaho 83843

7. Montana Dr. G. A. Nielsen, Dept. of Plant and Soil Science, Montana State College, Bozeman, Montana 59715

8. Nevada Dr. F. F. Peterson, Plant, Soil, & Water Science, University of Nevada, Reno, Nevada 89507

9. New Mexico Dr. **LeRoy** Daugherty. Dept. of Agronomy, New Mexico State University, Las **Cruces**, New Mexico 88001

10. Oregon Dr. G. H. Simonson, Dept. of Soils. Oregon state University. Corvallis, Oregon 97331

11. Utah Dr. A. R. Southard, Soils & Meteorology

Dept. Logan. Utah 84321

12. Washington Dr. Alan J. Busacca, Dept. of Agronomy

and Soils, Washington State University,

Pullman. Washington 99164

13. Wyoming Dr. Larry C. Munn, Dept. of Soils,

University of Wyoming, Laramie, Wyoming

82070

III. Principal Soil Cot-relator or Representative:

Western States Richard W. Kover, Soil Conservation

Service, USDA, WNTC, 511 N.W. Broadway,

Rm. 514. Portland, Oregon 97209

IV. Soil Survey Laboratory, SCS, Lincoln:

Dr. W. D. Nettleton, Soil Scientist National Soil Survey Laboratory

Room 345, Federal Bldg.. U.S. Courthouse

Lincoln, Nebraska 68508

V. Cartographic Staff, SCS, Fort Worth, Texas:

Donnell L. Stelling

Soil Conservation Service, USDA National Cartographic Center Building 23, Felix & Hemphill

P.O. Box 6567

Fort Worth, Texas 76115

VI.

- Region 3 Owen J. Carleton, Forest Service, USDA,
   517 Gold Ave.. S.W.
   Albuquerque. New Mexico 87101
- 4. Region 4 Tom Collins, Forest Service, USDA Federal Building (801)・6かち・5357 Ogden, Utah 84401 万75・556・5357
- 5. Region 5 Charles **Goudey,** Forest Service, USDA, 630 **Sansome** Street San Francisco, California 94111
- 6. Region 6 Dr. R.T. **Meurisse,** Forest Service, USDA, P.O. Box 3623
  Portland, Oregon 97208
- 7. Region 7 Tom Sheehy, Forest Service, P.O. Box 1628
  Juneau, Alaska 99801

#### VII. Bureau of Indian Affairs:

Donald Jones, Bureau of Indian Affairs, USDI, P.O. Box 3785 Portland, Oregon 97208

Thomas Wiggins, Bureau of Indian Affairs, USDI, Navajo Indian Reservation Window Rock, Arizona 86515

Henry Waugh. Bureau of Indian Affairs, USDI, P.O. Box 8327 Albuquerque. New Mexico 87108

Robert A. **Klink,** Bureau of Indian Affairs, USDI, P.O. Box 7007 Phoenix, Arizona 85011

# VIII. Bureau of Land Management:

Jim Stone, Bureau of Land Management. USD1 Denver Service Center. Bldg. 50 Division of Resource Inventor System Denver. Colorado 80225

#### IX. State Soil Scientists, Bureau of Land Management:

1. Alaska Lyle Linnell, BLM, USDI 555 Cordova Street, Pouch 7-512

(PLEASE ADD YOUR TELEPHONE NUMBER)

2. Arizona Robert Roudabush, BLM, USDI

2400 Valley Bank Center 201 N. Central Ave. Phoenix, Arizona 85073

3. California vacant

4. Colorado Ernest Vesswick, BLM, USDI

Rm. 700, Colorado State Bank Bldg.

1600 Broadway

Denver, Colorado 80202

5. Idaho Darwin Jeppsen, BLM, USDA

BLH District Office 940 Lincoln Road

Idaho Falls, Idaho 83401

6. Montana Myron Rollins, BLM. USDA

Granite Tower 222 N. 32nd St. P.O. Box 30157

Billings, Montana 59107

7. New Mexico Verlyn Saladen, BLM, USDI

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Santa Fe. New Mexico 87501

8. Nevada **Jerry Harman**, BLM, USDI

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3008 Booth Street Reno, Nevada 89509

9. Oregon Byron Thomas, BLM, USDI

729 N.E. Oregon Street

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Portland, Oregon 97208

10. Utah vacant

11. Wyoming William Crane, BLM, USDI

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# X. Bureau of Reclamation:

Richard Piper Head, Land Utilization Denver Federal Center Denver, Colorado 80225

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#### APPENDIX A

#### THE STEERING COMMITTEE

#### of the

#### WESTERN REGIONAL COOPERATIVE SOIL SURVEY CONFERENCE

#### I. Membership

The Steering Committee consists of the following members:

Principal Soil Correletor, Western States (permanent chairman)

The current (or forthcoming) conference chairman

The current (or forthcoming) conference co-chairman

The current (or forthcoming) conference secretary

The immediate past conference chairman

All other permanent members of the conterence from the host

Membership changes upon election of officers at the conference

# II. Meetings and Communications

#### A. Regular Meetings

At least one meeting is held at each conference. Additional meetings may be scheduled by the chairman as the need arises. Whenever possible, the committee will meet at conference center prior to the conference to review space and accommodations, and **to** assure equipment will be available for the conference.

#### B. Extra Meetings

Meeting of the committee may be held between conferences if convenient and necessary.

C. Most of the committee's communications will be by correspondence. Copies of all correspondence related to the conference will be sent to both the Steering Committee chairman and the conference chairman.

### III. Authority and Responsibilities:

#### A. Conference Members and Participants

1. The Steering Committee formulates policy on conference membership and participation. Final approval or disapproval of policy changes is by a vote of the conference.

2. The Steering Committee approves the attendance of guests or nonmembers at a specific conference.

#### B. Conference Committees and Committee Chairman

- 1. Upon the recommendation of the conference, the Steering Committee formulates the conference committee membership and appoints committee chairman. Insofar as possible, committee membership is guided by expressions of individual preferences and interests. The Steering Committee will, however, strive to assure that no one committee is dominated by any single state or agency.
- 2. Upon the recommendation of the conference, the Steering Committee is responsible for the formulation and transmittal of specific charges of the committee chairman.

#### C. Conference Policies

The Steering Committee is responsible for the formulation of statements of conference policy. Final approval of such statements is by vote of the conference.

#### D. Liaison

The Steering Committee is responsible for maintaining liaison between the conference and (a) the National and other regional conferences, (b) the Western Regional Soil Survey Work Group. (c) the Western experiment station directors, the state or regional and National offices of the Soil Conservation Service, Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and Bureau of Reclamation, (d) the Western Soil and Water Research Committee, (e) other committees or work groups associated with the conference, and (f) other participating agencies or groups.

# CONFERENCE MAILING LIST

#### SOUTHERN AND WESTERN WORK PLANNING CONFERENCE OF THE NATIONNI, COOPERATIVE SOIL SURVEY - 1984

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# NATIONAL COOPERATIVE SOIL SURVEY

# Western Regional Conference Proceedings

# San Diego, California February 8-12, 1982

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PROCEEDINGS OF

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE

OF THE

NATIONAL COOPERATIVESOIL SURVEY

SAN DIEGO, CALIFORNIA FEBRUARY 8-12,1982

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Diego, California February B-12, 1982

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Interagency Resources Evaluation Techniques Program Jim Hagihara, Rocky Mountain F&RES, Fort Collins

Premapping Investigations for Improving Soil Survey Operations Dr. Cliff Hontaque, Montana State University

Status of SCS Automated Soil Data Systems Bill Reybold, SCS, Washington, D. C.

Research and Development of Soil Resource Information Systems Dr. R.D. Hell, Colorado State University

Application of a Soil Resource Information System Tom Priest, SCS, Denver

Computerized Soil Maps
Don Stelling. SCS, Portland

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Characterization of Slope Classes for Soil Survey Utilizing Digital Elevation Models
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# **EXECUTIVE SUMMARY**



The theme of the 1982 western conference was oriented towards improving soil survey quality and efficiency.

The following are highlights of committee recommendations (see committee reports for specific wording and discussion).

# COMMITTEE 1 - APPLICATION OF FIELD PROCEDURES FOR DIFFERENT ORDERS OF SOIL SURVEY

- That symbols be used on field sheets to identify the field procedure used to identify the composition of a delineation.
- That the oercentage of the field procedures used to identify the composition of each mao unit should be given in the published soil survey report.
- That the procedures for identifying the composition of delineations and delineation boundaries, and the summary classification table contained in the committee report be field tested.
- That the committee be continued for the 1984 conference and that Dick Cline serve as chairman. Activities to include:
  - 1. Initiate action on field testing (1982 field season).
  - 2. Compile a draft document explaining and defining the "Kinds of Soil Surveys" concept for field testing.
  - 3. Review and amplify definitions.

# <u>COMMITTEE 2</u> - DOCUMENTATION FOR HIGHER ORDER SURVEYS

- Continue the current policy of allowing a survey area to select one of the following options.
  - 1. One detailed pedon description with range in characteristics to represent each family regardless of the number of phases of the family used in the survey area; or
  - used in the survey area; or

    2. A detailed pedon description with range In characteristics to represent each phase of the family as used in the survey area.
- That reference pedon descriptions for higher categories continue to be quided by NSH 307.7(a)(2) and 603(a)(2)(IX). That when a Reference Pedon is used it be footnoted as follows: "This Reference Pedon is an example of a soil within this category. It is not necessarily representative of this soil as mapoed throughout the survey area."
- That Dhase naming (subgroup are higher) be allowed to include items used in SOIL TAXONOMY. provided these terms ensure clarity, maintain brevity and do not duplicate class limits. That Chapter 5 of the Soil Survey Manual include this provision.

- That the policy (West TSC Bulletin No. W430-1-17) of not requiring the establishment of a soil series to recognize a new soil family be continued.
- That the definition of non-progressive soil surveys include parts of areas previously published (at a higher order) when the published Survey no longer meets user needs. The reasons and process for doing this would be described in the Memorandum of Understanding.



- That this committee be discontinued.

#### COMMITTEE 3 - SOIL RATING CRITERIA FOR OFF-ROAD VEHICLES

- That the ORV quide in Section 403.6 of the National Soils Handbook be deleted from the Handbook as soon as oossible.
- That the quide (developed by the committee) for rating soil limitations for wheeled off-road vehicles serve as a prototype for field testing, and be reviewed by other NCSS regions.
- That the bibliographies on the effects of off-road vehicles on the environment by R. H. Webb and H. G. Wilshire, and the BLM Desert Plan Staff be used by NCSS cooperators.
- That this committee be continued to review field testing of proposed criteria, and Marty Townsend serve as chairman.

# COMMITTEE 4 - EDUCATIONAL REQUIREMENTS TO MEET FUTURE NCSS NEEDS

- That the suggested soil curriculum from the 1980 Southern Regional Conference be reviewed along with this committee's findings to develop a model for the western region.
- That leadership be exercised so that loss of training opportunities due to fiscal contraints does not become long-lasting and irreversible, and opportunities for interagency participation in courses be maintained and encouraged.
- That OPM be advised to provide colleges and universities more specific information on courses and rating procedures considered for a high rating as soil scientist.
- That agencies consider developing multi-media training courses in lieu of traditional classroom instruction.
- That this committee continue.

#### **COMMITTEE 5 - SOIL SURVEY INTERPRETATIONS**

- That an ad hoc workgroup (see committee report for members) develop criteria for desired forest and range interpretations.
- That conference members send interpretations desired which are not presently on form SCS-5 to the ad hoc group by April 1, 1982.

- That workgroup interpretations be field tested and results reported to 1984 conference.
- That this committee be continued with Bob Meurisse as chairman.
- That a new committee of Plant and soil scientists be formed to develop a framework of quidelines for correlating ecological sites, and develop a catalog of natural resource computer data files.

# AD HOC GROUP - LABORATORY ANALYSES WORKSHOP

- That the National Soil Survey Laboratory (NSSL) be charged with the responsibility of reviewing current methods used in soil characterization and determine if any new analytical methods are warranted.
- That the NSSL provide cooperating laboratories with examples of their data base system
- That the NSSL data base system be accessable to the cooperating laboratories in a way that would provide a usable interchange of data.
- That the Laboratory Analyses Workshop be a continuing committee of the conference, and Bill Allardice serve as 1984 chairman.

#### SUMMARY OF OTHER ACTIVITIES

The western region is very concerned about the lack of cross-sectional representation from the west in the proposed makeup of the National Conference. The western region is unsuroassed in the diversity of soils, soil-related resources, soil management problems, and NCSS cooperators. The representation of the western region in the National Conference should be more consistent with the magnitude of this diversity.

The 1984 conference steering committee will be reviewing the by-laws and presenting their findings and revisions to the 1984 conference.

The Regional Soil Taxonomy Committee will be a standing committee of the conference, with replacement members to be elected by the conference.

The invited papers demonstrated that opportunities exist for improving soil survey quality, efficiency, and usability. Also, cooperation between agencies created some of the opportunities (funding, exoertisel. Some activities may cost more, but become affordable when shared with other benefiting cooperators. Furthering creative inter-agency coordination and cost-sharing may well play an important role in maintaining and improving soil survey programs. However, no matter how innovative new technology may seem, there is no substitute for carrying out the basics correctly. Dick Dierking's paper reminds us of that important fact.

To follow through on recommendations of the conference that oertaln to the National Soils Handbook and Soil Survey Manual, the 1982 conference steering committee will submit oroposals through the appropriate channels.

The western region supports the efforts of the Northeast Conference in developing greater inter-regional communication. The perspective that Ed Ciolkosz provided on the differences and similarities between the northeast and west was valuable. The western region will send copies of the proceedings to the other regional conferences.

The 1984 conference will be hosted by the NCSS members representing New Mexico in latter February.

The 1984 conference Steering Committee is:

Gary Muckel, Soil Conservation Service - Conference Chairman LeRoy Daugherty. New Mexico State Univ. - Conference Co-chairman Owen Carleton, Forest Service Verlyn Saladen, Bureau of Land Management Henry Wauqh, Bureau of Indian Affairs Dick Kover, TSC Representative - Steering Committee Chairman Chuck Goudey. Forest Service - Past Conference Chairman

The conference again thanks the committee chairman, recorders. speakers, and participants for their efforts in making the conference successful.

Chuck Goudey Chairman

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Diego, California February 8-12, 1982

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# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Dieqo. California February 8-12, 1982

# **AGENDA**

MONDAY, February 8	
10:00 - 1:00	Reqistration • Kon Tiki Room
	General Session - Kon Tiki Room
	Chairman - Chuck Goudey
1:00 - 1:20	Announcements and Introductions
1:20 - 2:15	National Perspective for Soil Survey William Reybold, Staff Leader for soil survey and correlation, SCS, Washington, D.C.
2:15 - 3:00	Soil-Climate Predictors for Range and Forest Land Potentials in Western U.S. Dr. LeRoy Daugherty, New Mexico State Univ.
3:15 - 5: oo	Committee Review of Draft Reports Committee 1 - Kon Tiki Lounge Committee 2 - Moana Room Committee 3 - Hilo Room Committee 4 - Kon Tiki Room Committee 5 - Kon Tiki Room
TUESDAY, February 9	
8:00 - 5:00	Discussion Groups (Committee Reports)
SEE ATTACHMENTS FOR	DISCUSSION GROUP ASSIGNMENTS, SCHEDULE AND LOCATIONS.
8:00 - 5:00	Laboratory Analyses Uorkshoo - Hilo Room Bill Allardlee, Chairman
WEDNESDAY. February 10	
	General Session - Kon Tiki Room
	a. m Chairman - Jim Stone
8:00 = 8:45	Interagency Resources Evaluation Techniques Program Jim Haqihara, Rocky Mountain F&RES, Fort Collins

8:45 - 9:15	Premapping Investigations for Improving Soil Survey Operations Or. Cliff Montagne, Montana State Univ. Jack Rogers, SCS. Bozeman
9:15 - 10:00	Status of SCS Automated Soil Data Systems Bill Reybold, SCS. Washington O.C.
10:15 - 10:45	Research and Development of Soil Resource Information Systems Dr. R.D. Heil/Gil Hersh, Colorado State Univ.
10:45 - 11:00	Application of Soil Resource Information Systems Tom Priest, SCS, Denver
11:00 - 11:45	Computerized Soil Maps Don Stelling, SCS, WTSC, Portland
11:45 - 12:00	Di scussi on
	p.m. Chairman - Chuck Goudev
1:00 - 1:30	Soil Data Base Management System - Forest Service Chuck Goudey, FS, San Francisco
1:30 - 2:00	Characterization of Slooe for Soil Surveys Utilizing Digital Elevation Models Steve DeGloria. U.C., Berkeley
2:00 - 2:30	Determining Soil Temperature/Moisture Reqimes in Forest and Rangelands Utilizing Thermal Remote SensIng Steve DeGloria, U.C., Berkeley
2:30 - 3:15	<ul> <li>Remote Sensing Applications in Soil Survey</li> <li>Mao Unit Design and Quality Control     Doug Harrison, SCS, Idaho</li> <li>Field Procedures     Rob Roudabush, BLM, Phoenix</li> </ul>
3:30 - 4:00	Interpreting Land for Irrigation Suitability Susan Hoffman, BOR, Sacramento
4:00 - 4:30	Ooportunities for Expeditina Soil Correlation Dick Dierking. WTSC, Portland
4:30 - 4:45	Summary of Laboratory Analyses Workshop Bill Allardice. U.C., Davis
4:45 - 5:00	NE Cooperative Soil Survey Conference Briefina Ed Ciolkosz, Penn. State Univ.
5:00 - 5:15	Discussion

THURSDAY, February 11	
8:00 - 9:45	Committees meet to complete reports Committee 1 - Kon Tiki Lounge Committee 2 - Moana Room Committee 3 - Hi 10 Room Committee 4 - Kon Tiki Room Committee 5 - Kon Tiki Room
	General Session - Kon Tiki Room
	Chairman - Jim Stone
lo:oo - 10:20 10:20 - 10:40 10:40 - 11:00 11:00 - 11:20 11:20 - 11:40 11:40 - 12:00	Agency Reports Agricultural Exd. Station - Dr. Gordon Huntington Bureau of Indian Affairs - Don Jones Bureau of Land Management - Jack Chuqq Bureau of Reclamation - Greq Brockman Forest Service - Kermit Larson Soil Conservation Service - Dick Kover
1:00 - 2:45	Individual Aqency Meetings Aqricultural Experiment Station - Kon Tiki Lounge Bureau of Indian Affairs - Kon Tiki Room Bureau of Land Management - Moana Room Bureau of Reclamation - Room P-57 Forest Service - Hi10 Room Soil Conservation Service - Kon Tiki Room
	General Session - Kon Tiki Room
	Chairman - Chuck Goudey
3:00 - 5:00	Business Meeting
FRIDAY, February 12	
	General Session - Kon Tiki Room
	Chairman - Chuck Goudey
8:00 - 8:30 8:30 - 9:00 9:00 - 9:30 9:30 - 10:00 10:0D - 10:30	Committee Reports Committee 1 - Jerry Harman Committee 2 - Dan Ernstrom Committee 3 - Jim Pomerening Committee 4 - Jerry Simonson Committee 5 - Loren Herman
10:30 - 11:00	Discussion
ll:oo	Adj ourn

# INSTRUCTIONS FOR COMMITTEE CHAIRMEN AND RECORDERS

Committee Chairmen will assign a Recorder to qather additional ideas, consensus of opinion, and recommendations during the committee review of the pre-conference report (Monday). From this review, the Chairman and Recorder will develop a revised report.

The Chairmen will present the revised report to each of the three discussion groups (Tuesday). The Committee Recorder will accompany the Chairman, and record the concensus and/or recommendations of the group discussions. The Chairman and Recorder will meet to develop a revised draft of the report. This draft will consider the consensus of the individual discussion groups and their recommendations.

The revised draft will be reviewed by the committees (Thursday) and a final report developed.

Only a brief summary of the report and

# DISCUSSION GROUPS

Participants and quests have been assigned to one of three discussion groups. The name at the head of each column is the room in which each group will meet. A discussion leader has been selected for each group, his name appears at the top of each list. Conference participants not listed on a discussion group may select a group (try to maintain a balance of numbers between groups).

B. Allardice  D. Carleton  J. Chuqq  G. Brockman  V. Carter  E. Ciolkosz  C. Case  L. Daugherty  J. Haqihara  R. Cline  M. Fosberq  O. Harju  W. Crane  R. Hoppes  W. Harrison  P. Derr  G. Huntinqton  R. Heil  R. Dierking  G. Madenford  S. Hoffman  L. Fletcher  G. Muckel  H. Holdorf  C. Goudey  L. Minn  D. Jones  H. Ikawa  D. Pease  R. Kerr  R. Klink  J. Raqus  R. Kover  C. Montaque  M. Rollins  K. Larson  D. Nettleton  H. Sato  G. Latshaw  J. Roqers  D. Smith  J. Mallory  H. Rounsaville  D. Snyder  E. Naphan  V. Saladen  J. Stone  G. Nielson  D. Stellinq  M. Thessen  T. Priest  H. Sunmerfield  H. Wauqh  W. Reybold  L. Walker  E. Wesswick  T. Ryan  B. Thomas	Kon Tiki Lounge	Moana Room	Kon Tiki Room
G. Brockman  V. Carter  E. Ciolkosz  C. Case  L. Daugherty  J. Haqihara  R. Cline  M Fosberq  O. Harju  W Crane  R. Hoppes  W Harrison  P. Derr  G. Huntinqton  R. Heil  R. Dierking  G. Madenford  S. Hoffman  L. Fletcher  G. Muckel  H. Holdorf  C. Goudey  L. Minn  D. Jones  H. IKawa  D. Pease  R. Kerr  R. Klink  J. Raqus  R. Kover  C. Montaqne  M Rollins  K. Larson  D. Nettleton  H. Sato  G. Latshaw  J. Roqers  D. Smith  J. Mallory  H. Rounsaville  D. Snyder  E. Naphan  V. Saladen  J. Stone  G. Nielson  D. Stellinq  M Thessen  T. Priest  H. Summerfield  H. Wauqh  W Reybold  L. Walker  E. Wesswick  T. Ryan	Fred Peterson	Shelby Brownfield	Tom Collins
C. Case  L. Daugherty  J. Haqihara  R. Cline  M Fosberq  O. Harju  W Crane  R. Hoppes  W Harrison  P. Derr  G. Huntinqton  R. Heil  R. Dierking  G. Madenford  S. Hoffman  L. Fletcher  G. Muckel  H. Holdorf  C. Goudey  L. Minn  D. Jones  H. IKawa  D. Pease  R. Kerr  R. Klink  J. Raqus  R. Kover  C. Montaque  M Rollins  K. Larson  D. Nettleton  H. Sato  G. Latshaw  J. Roqers  D. Smith  J. Mallory  H. Rounsaville  D. Snyder  E. Naphan  V. Saladen  J. Stone  G. Nielson  D. Stellinq  M Thessen  T. Priest  H. Summerfield  H. Wauqh  W Reybold  L. Walker  E. Wesswick  T. Ryan	B. Allardice	0. Carleton	J. Chuqq
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# NATIONAL PERSPECTIVE FOR SOIL SURVEY WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FEBRUARY A-12, 1982

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# Soil-Climate Predictors for Range and Forest Land Potentials in the Western United States

Presented by L. A. Daugherty New Mexico State University

I would like to express the appreciation of the representatives of the Experiment Stations for the opportunity to express our views and concerns about the use of soil-climate predictors in soil survey. We believe that soil-climate interpretations from soil surveys will play a critical role in assessing grazing, forestry, and dryland-crop use potentials for western lands in coming years. Tens of millions of acres of depleted range and forest lands are being inventoried currently by soil surveys to help guide management and assist in predicing vegetative potential. In order to predict potential from soil information, either the kind of soil or some of its properties must be related to the vege-Presently most soil-vegetation relations are known tative potential. only locally and have not been correlated across administrative or state boundaries in the western region. Our understanding of the soil-vegetation relationships is largely empirical, and are usually possible only in areas not too depleted. Relationships are only known generally between vegetation and kind of soil rather than by using specific soil properties that might be identified for numerous kinds of soils.

One set of specific soil properties that relates to vegetation is called "soil climate". Soil climate is a term we use for the soil moisture and temperature regimes that change through the seasons in patterns characteristic of broad groups of soils. These regimes do reflect atmospheric climate, but are strongly modified by local features These regimes do such as slope, aspect, infiltration rate. and soil vater-holding capacity which are related to local vegetation patterns. Soil climate is so biologically critical in predicting the productive potential of range and forest that its temperature and moisture components are used as major diagnostic criteria for classifying and identifying soils. these regimes were first used in soil classification which serves soil survey, circa 1965, they had to be identified by estimates based on the atmospheric climate of broad, poorly understood areas. Temperature and moisture regimes of too few specific soils were known to establish guidelines for locally variable soils and vegetation. More seriously, the class boundaries of soil temperature and moisture regimes were calibrated for major changes of cultivated agriculture. mostly outside

"Many of the definitions of taxa that are extensive in the United States are far from perfect, particularly regarding their soil moisture regimes. These are known in a general way, but more actual measurements are needed to refine the present definitions. We are more confident about the classification of these soils than we are about the definitions. Changes seem certain, and supplements that revise some of the definitions can be expected."

"Elsewhere taxonomy **states** that the classification of the soil series in the United States was done in part by knowledge of the moisture regime. **The** definitions of soil moisture regimes used In soil taxonomy were fitted to desired boundaries. If future studies show that the classifications of the soils are not in agreement with these definitions. they are **more** likely to change the **definitions** than the classifications."

The general concepts of soil climate have proved valid and useful in broad contexts. Problems in field identification and interpretations have been identified. **The** substantiating data, however, are mostly only locally known and have not been regionally organized, "or have *regional* problems of class breaks been effectively tested and resolved.

The problems we face dealing with soil-climate are regional in scope. Most areas of different soil moisture regimes and vegetation cross one or more state boundary. There is no western state that does not share the problems of consistent identification and interpretation of a distinctive soil-climate area with another state.

Regional need for a coordinated research effort was reflected by the actions taken by this conference in 1980. We voted to strongly recommend soil-climate research. This conference represents the operational leadership of the National Cooperative Soil Survey in the West. Most of you face daily problems of taxonomic identification of soil supporting more or less contrasting vegetation.

In order to research the problems related to soil-climate predictors, we need to compile the information learned by past researchers. They have taught us that biological processes in the soil are controlled in general by the climate within the soil, that is the soil temperature and moisture. Each plant species has Its own temperature and moisture Climax vegetation in an area is thought to be a reflecrequirements. tion of the moisture regime. This idea is the basis for using plant communities to infer soil moisture in the field. Soil moisture, however, is not the only factor that is important in defining the range of a plant community. The area occupied by a plant community is also limited by the component plant-species tolerance of a number of environmental parameters. This tolerance varies from plant to plant and has been referred to as the ecological amplitude of a plant.

Soil moisture regimes have not been used in all past soil classification schemes. Properties accessory to soil moisture have been widely used in the past, but it is only during the past 30 years that soil moisture was used as a definitive criteria. Consistent usage of soil climate was not reached until the 1967 suppliment of the "7th Approximation" was issued. The use of soil moisture regimes in soil classification is not universal today. Soviet publications suggest that soils can be grouped according to soil moisture, but there is little agreement on how they should be grouped. The phrase "soil moisture regime" is used arbitrarily and inconsistently in the literature and have numerous connotations varying videly from the usage in Soil Taxonomy,

The members of the soil survey staff who wrote soil taxonomy recognized that the soil moisture regime was not only an important property of the soil, but it is also a determinant of processes that can go on in the soil. It is generally recognized that during geologic time there have been significant changes in climate. Soils that could have formed only in a humid climate are now preserved in some places in an arid climate. These soils have relict features that reflect the former moisture regime and have other features that reflect the present moisture regime.

The soil moisture regime is only a partial function of climate. In an arid area, the soils are not necessarily dry. They may be dry, moist or wet. depending on their position in the landscape, because they may receive water from sources other than the rain that falls on them. In any given landscape that has uniform climate, adjacent soils may have different moisture regimes.

Each of the moisture regimes in the history of a soil is a factor in the genesis of that soil and is the cause of many accessory characteristics. Host of the accessory characteristics, however. and those most important for interpretations are associated with the present moisture regime, even if some of the earlier moisture regimes differed widely from the present one. Soil taxonomy stresses that if any of the marks of the moisture regime are to be used as diagnostic properties. it is essential to specify the nature of the present moisture regime. Unless this is done, there cannot be any characteristics accessory to those that are diagnostic. It is for this reason that the moisture regime is used in defining classes in the very high categories.

There is a very large amount of common knowledge about the moisture variations within soils over time. especially in the humid. agricultural environments. For arid and semiarid environments, however, the information is more scant. There are few long-term records and still fewer that can be related to the energy concept of soil moisture. Those of us who work with soil know how the moisture changes with the seasons, but our knowledge is largely qualitative. Due to lack of publication, the concepts are not uniform or consistent.

There have been many methods devised to relate soil moisture to meteorological records. All of these methods have some shortcomings. Most of these techniques use a Thornthwaite method for estimating evapo-The Newhall model of the Soil Conservation Service is used in many areas of the vest and is probably best known by those of us in attendence at this conference. In this method, moisture distributions are predicted by assuming the potential evapotranspiration is uniformly distributed over all the days of the month, and moisture removal is proportional to available water. Rainfall is distributed by assuming ½ of the mean monthly precipitation falls in one storm at the middle of the month, and the rest falls as light showers throughout the remainder of the month. Moisture regimes are calculated for periods when the soil temperature at 50cm reaches 5°C. This model does not take into account soil differences and landscape position. It is dependent on long-term climatic data. Orographic changes in the west make it difficult to extrapolate climatic data over long distances. Climatic stations are often located in valleys and do not represent the mountainsides.

Very little work has been done in comparing soil **moisture** regimes, as defined in soil taxonomy. The models used to predict soil moisture regimes have had very little testing.

Up to this point, we have only addressed the soil moisture part of soil-climate. Soil temperature is an integral part of the soil climate and cannot be separated from a study of soil-climate-vegetation relationships. Soil Taxonomy points out that plants have one or more soil-temperature requirements that are met by the soils of their native environment. Soil temperature, therefore, has an important influence on biological, chemical and physical processes in the soil.

At any moment the temperature within a soil varies with depth. The temperature near the surface fluctuates with the hours of the day and with the seasons of the year. The fluctuations may be very small or very large according to the environment. Because temperature is so variable, or perhaps because it is not preserved in samples, some pedologists have felt that temperature is not a property of a soil. Most who work with soils in a limited geographic area take soil temperature for granted because the temperature of most soils in a limited area are similar. Observers are all inclined to notice the properties that differ among soils and to focus attention on them. The mean annual soil temperature is related most closely to the mean annual air temperature, but this relation is affected to some extent by the amount and distribution of the rain and the amount of snow, the protection by shade and by the organic mat in forests, and by the slope aspect and gradient.

Moisture can be exceedingly important in reducing fluctuations in soil temperature.

One of our concerns is predicting the soil climate **from** vegetation. Vegetation has the capacity **to** integrate the differences in soil physical properties, moisture **and** temperature and live **in** a unique environment. The specific requirements of each plant, however, is not know. I" fact, the environmental requirements are known for very **few** plants. Soils and plants have been studied along gradients, but very rarely has the soil climate been monitored.

A general lack of agreement on specific use of soil climate parameters in soil survey has led the Western Regional Coordinating committee on soil survey representing the experiment stations to design a regional research project. The general objective of this project is to improve the utility of soil-climate identifications that are taken from soil maps and used to help predict potentials for range and forest lands in the western United States. Two major phases or sub-objectives of the project are sequential and the timing of their initiation and completion is integral to the success of the research.

The first phase of the project is to evaluate how the present soil-climate criteria of the Soil Taxonomy have been applied in soil surveys of western range and forest lands and how the geographical patterns of soil climates, as presently mapped, relate to vegetation patterns.

Initially, all participating states will objectively delimit their major soil climate boundaries, as now perceived, from existing soil maps and climatic data. In areas of minimal or no data, best estimates will be used. The categories of Soil Taxonomy will be the useful units in delineation, depending upon information available. Selected, field-derived, soil-climate maps and vegetation maps will be correlated against maps of soil moisture and temperature regimes calculated from climatic data to discover problem situations. The preliminary maps will be based on a "standard" nearly level exposure. Later work will take slope and aspect variations into account.

Correspondence of the soil climate areas between adjoining states will be noted and evaluated. Coordination of this portion of the study will be effected, where possible, with states adjoining the Western Region. Adjustment of non-joining boundaries will not be made at this stage.

Working maps of this information will be compiled at the state level at the scale of 1:1,000,000. The information documented in the state maps will be shared with each of the cooperating states in order to compile a working regional map.

Within each state, a" evaluation vi.11 be made of the formal and informal field criteria for soil climate that have been used to identify soils by the principal mapping agencies observing National Cooperative Soil Survey standards. This will be done by questionnaire and by discussion with active field scientists. A regional core list of standard questions will be developed which will be used by all states. This

question list, however. will be augmented to fit particular state conditions. This effort will be designed in a manner to document the experiences of field scientists as a aid in evaluation of existing maps, as well as to indicate possible problems in identifying soil climate classes.

Based on the above and other data, each state will evaluate, appropriate to its conditions. the accuracy or anomalies of geographic correlation among kinds of vegetation and regionally representative soils mapped by present criteria.

The current understanding of soil-climate-vegetation relationships will be summarized through compilation of a draft version of a regional soil-climate map and a report that will include details on agreements and discrepancies.

The shared findings of the first phase of the project, viewed regionally as well as locally, will provide the basis for the work to be undertaken in the second phase of the project.

The second phase of the project is to modify the soil-climate criteria where needed. or develop new criteria for better prediction of vegetative potential **from** additional baseline soil-climate data. and formulate means of extrapolating this information.

Initially, the coordinated efforts of the participating states will be directed toward a" examination of alternative definitions of soil climate that may relate to such factors as: rooting habits of common range and forest vegetaion; critical levels of soil temperature and moisture affecting such vegetation; and year-to-year variability of soil moisture and temperature.

Related to this, some states will examine the relation of soil moisture duration to waterholding capacity for deep rooted vegetation. Some will examine the kind and amount of vegetative growth in relation to various levels and durations of heat energy in different soils now placed in the same soil temperature regime. Others in northern parts of the region, or with significant areas of high mountainous lands, will study definitions, currently in question, that separate soils with cryic and frigid soil temperature regimes. Some **states** may include **dryland-**cropped soils **amond** their experimental sites.

Soil morphology will be studied to determine which features, if any. are accessory to soil climate and which may be used as field mapping criteria or guides to the appropriate soil climate regimes with emphasis on large tracts of range or forest lands that cut-over, burned or otherwise changed to the point where reliable plant indicators are lacking.

The regional research group will search for reliable indicator plants that correlate in occurrence or in some growth habit with soil moisture and/or soil temperature distribution patterns on the landscape. Procedures will be developed to geographically extrapolate these relationships by bioclimatic techniques.

The final product of the two phases of the research project will Include a regional report on the findings in soil climate and vegetation relationships on western range and forest lands. This will include publication of a regional soil-climate map incorporating all newly acquired information.

The soil-climate research that we propose is aimed primarily toward interpretations for perennial range and forest vegetation. However, it also will be useful for predicting long-term soil moisture and temperature characteristics for dryland cropped soils. Some states may find need to include dryland-cropped soils among their experimental sites because of impending land-use conversions from irrigated to dryland crops or range, or from range or forest to cropland.

Benefits from this research will be in increased confidence as to where and with which techniques range and forest productivity can be increased. New understanding of soil-climate regimes should not require re-napping, rather only changes in identifications and Interpretations. As additional benefits, we will be producing baseline data and maps for range, forest, and hydrological research and the extrapolation of their results.

# The Interagency Resources Evaluation Techniques Research and Development Program

James S. Hagihara<sup>1</sup>

Western Regional Technical Work Planning Conference for Soil Survey, San Diego, Californla February 8-12, 1982

The Resources Evaluation Techniques Program (RET) is a nationwide research and development program located at the Forest Service Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado. The mission of the RET Program is "to maintain and improve capabilities for national inventories and analysis for all of the nation's natural renewable resources."

# Background

The justification for developing the multiagency RET Program was based on four major related land management acts passed by Congress during the 1970's. They are:

- Forest and Rangeland Renewable Resources Planning Act of 1974 RPA (PL 93-378).
- National Forest Management Act of 1976 NFMA (PL 94-588).
- Federal Land Policy and Management Act of 1976 FLPMA (PL 94-597).
- Soil and Water Resources Conservation Act of 1977 RCA (PL 95-192).

All four of these acts mandated common requirements. These common themes include: (1) preparation and maintenance of continuous resource inventories, (2) coordination and cooperation among resource agencies and organizations to avoid duplication of inventory and planning, (3) determine the changes in stat:.?. and condition, both current and potential. of the resource base, (4) determination of resource interactions as affected by management alternatives, and (5) preparation of periodic assessments or appraisals of the nation's renewable natural resources.

In view of these legislated acts, the interagency RET Program was developed in late 1976. The cooperating agencies are the Bureau of Land Management, Fish and Wildlife Service, Forest Service, Geological Survey, and Soil Conservation Service. The Council of State Planning Agencies requested participation and joined the Five-Agency Grouo in 1979. They will represent the 50 states and provide necessary coordination.

# Objectives and Goals

The objectives of the Program are to develop and improve for national, regional, and local renewable natural resource assessments and appraisals an effective, multipurpose ecological land classification system, renewable natural resource inventory techniques through effective remote sensing and sampling strategies; maintenance of RPA automated data bases; and assistance in applications of techniques and procedures developed for classification and Inventory.

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These objectives are being met by conducting the following research and development studies.

- a. Land Classification--The conceptual basis for an ecological component national land classification system has been provisionally agreed upon by the Interagency Agreement members (BLM, FS, FWS. GS. SCS). The system includes hierarchical classification of four ecosystem elements: vegetation. soil, water, and landform, and preliminary procedures for integrating the elements into ecological units. In order to translate the concept into full application. potential natural vegetation must be linked to existing vegetation. A water classification considering water to support life on and in the water Standard definitions for landform characterization must be must be completed. A classification system for existing vegetation amenable to remote sensing must be developed. Scientific procedures forintegrating element classifications into ecological units must be developed. An evaluation of the inherent information content of alternative classification systems will be A manuscript entitled "A Component Land Classification for the A Status Report" is currently awaiting publication. United States: Hopefully, it will be available within the near future.
- b. Inventory and Remote Sensing Techniques for Renewable Natural Resources—Improved estimators for phytomass, volume, and other vegetation parameters using existing inventory designs will be developed. The potential gains from remote sensing for multilevel sampling, stratification, geographical information systems, and monitoring vegetation change and trends will be determined. Vegetation measurement techniques will be developed to increase data collection compatibility and to reduce duplicity in inventories. Vegetation interpretation and measurement techniques from remote sensing will be improved or developed.
- c. RPA Automated Data Base Maintenance—RPA 80 Assessment automated data bases are operational and user requests for data and information are accommodated. New data and information must be added as they become available. The current data base must be merqed, where possible, into an Interrelational data base. A design for a fully integrated data base will be prepared. New procedures, such as data editing and report writing, will be developed. Evaluations on the feasibility of exchange among major renewable resource data bases of various agencies will be conducted. New procedures for manipulating the data bases will be incorporated. Data user request service will be maintained.
- d. <u>Jechnology Transfer</u>--Users of expected products from the Program will. be identified. An awareness program will be prepared to involve users in research planning and reviews of problem analyses, study Dlans, research reports. Interim quides will be Prepared on methods, techniques, or procedures for field testing with the users. Training plans will be developed to acquaint and involve users with the techniques, methods, or procedures. Feedback will be obtained, modifications will be made, and additional evaluations will be conducted if necessary. Methods, techniques, and procedures will be recommended for incorporation into manuals and handbooks.

In summary, the Resources Evaluation Techniques Program is charged with the responsibility of developing and Improving a national (a) ecological land classification system (b) renewable natural resource inventory and remote sensing techniques, (c) resource analysis techniques. and (d) application of new and improved knowledge through technology transfer.

#### PREMAPPING INVESTIGATIONS FOR IMPROVING SOIL SURVEY OPERATIONS

by

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February 1982
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#### **Introduction**

Initiating a soil survey requires the qathering, interpreting and understanding of all pertinent natural resource information. This is accomplished most efficiently by specialists working in their fields. The State Agricultural Experiment Stations and Land Grant Universities are mandated to participate in the National Cooperative Soil Survey. Universities and agricultural experiment station staffs have professional expertise as well as a knowledgeable student labor force to help gather and synthesize existing resource information for upcoming soil surveys. If Agricultural Experiment Station and University personnel are involved during initial formative Stages of a soil survey, they will likely continue to contribute throughout the soil survey. rather than only during yearly reviews. This oresentation documents involvement of the Montana Agricultural Experiment Station and Montana State University in premapping investigations for two upcoming Soil Conservation of the urveys.

# **Objectives**

The main purpose of these efforts is to utilize personnel and information resources of the University and Aqricultural Experiment Station to identify. qather. refine and Dresent existing resource data in order to help provide a solid foundation for initiation of soil survey procedures by Soil Conservation Service parties. Secondary objectives include documenting the usefulness of geological information for soil survey.

### **Procedures and Products**

We completed Dreliminary soil surveys in two Montana soil survey areas; one in the western intermountain valleys and one on the central plains. In western Montana we used the state and detailed qeologic maps to identify qeologic parent materials of soils. This information suoplemented by field reconnaissance allowed compilation of detailed (1:62,500) and generalized (1:250,000) qeologic parent material maps utilizing units reflecting bedrock, lithology, landform and regolith characteristics. The geology maps in

<sup>•</sup> J. Black, S. Harvey, A. Satterlee, T. Rayne, and J. Ruddell.

blueprint form, field notes, a bibliography, an assemblage of available pertinent literature and local climate data comprise a folio of information presented to the soil survey party.

In central Montana a queologist and soil scientist worked together to formulate and field check a 1:250,000 scale queeral queology map and synthesized this into a map showing soil parent material zones.

A plant ecologist identified vegetation communities occurring on the various qeologic parent materials and collected soil samples from some communities for pH and electrical conductivity determination. This work pointed out the following soil-vegetation relationships:

- 1. Cretaceous Colorado shale landscapes have acid shale zones with clay soil texture and pH of 3.6 to 4.2. These soils behave like acid sands and support Artemesia longifolia (long leaf sagebrush) and Calamovilfa longifolia (prairie sandreed). More basic (pH 5.5 to 7.7) clay loams support Artemesia tridentata (biq sagebrush) and Stipa comata (needleandthread).
- 2. Alluvial gravel cans overlyina Colorado shale have plant communities dominated by Yucca glauca (Yucca). Stipa comata (needleandthread), and Bouteloua gracilis (blue gramma).
- 3. When the Eagle sandstone occupies a landscape with Colorado shale, it develops sandy soils supporting <u>Calamovilfa lonaifolia</u> (prairie sandreed), In contrast to the clayey soils on Colorado shale.
- 4. Distichlis Stricta (inland saltgrass), Atriplex nuttalli (Nuttall's saltbush), and Sarcobatus vermiculatus (balck greasewood), species usually associated with saltv soils can also occur in soils with electrical conductivities as low as 0.7 mmhos/cm while Artemesia tridentata (biq saqebrush) which usually occupies basic non-saling soils may be found in soils with ph's as lows as 5.5 and electrical conductivities as high as 15.9 mmhos/cm.
- 5. Forest vegetation occupies sandstone and shale bedrock areas and scrublands are distributed over shale derived soils and lowland areas. The main grassland communities are spread over almost all of the qeologic parent materials.

We also gathered climate and land use data.

The parent material zones map in conjunction with the vegetation and climate information will help approximate a general soils map for this soil survey area.

# Conclusion

Agricultural experiment stations and universities can effectively participate in the National Cooperative Soil Survey by initiating preliminary soil surveys in cooperation with soil mapping agencies. The preliminary soil survey. accomplished with disciplinary experts, provides the soil survey oartwith a starting foundation based on available knowledge. It gives initial direction to the soil survey effort and involves disciplines such as geology, ecology, and climatology from the start. These efforts will lead to timely, efficient and accurate soil survey products.

# STATUS OF

SCS

# AUTOMATED SOIL DATA SYSTEMS

# Prepared for:

Western Regional Technical Work Planning Conference February 8-12, 1982

Presented by:

Bill Reybold

GORDON DECKER

IRIS

2/82

### SOIL INTERPRETATIONS

### scs-SOILS-5

Data input and maintenance is done by Iowa State University Staff, Ames, Iowa, under contract.

Data are stored and are available at the following locations:

- Data at Iowa State University are accessible via the Harris Equipment in batch mode. Several different kinds of outputs are available. (See National Bulletin No. 340-1-2 and 340-I-3..)
- Data at University of Illinois, Champaign, Ill., are accessible via interactive terminals. (See example output using the three available systems SMVS, ETIS and SMVS2.)

Data are stored and retrieval procedures are being tested at the following locations:

- Data retrievals at Colorado State University, Fort Collins, CO, are being tested in the System 2000 Data Base Management System
- Data retrievals at Washington Computer Center are being tested by the IRIS Staff using a flat file and EASYTRIEVE. (See example output for Alaska - AK.)

11 4 /SIS/SHVS

# HERIES MUTIPLE VARIANT SEARCH

A USDA SOIL CONSERVATION SERVICE IRIS SUBSYSTEM DEVELOPED IN EDDPERATION WITH THE U.S. ARMY CERL'S ETIS CROUP

TYPE CONTROL-D IF YOU WISH TO LEAVE THE SYSTEM.

TYPE "KELF" FOR HELF.

TYPE

EXAMPLE	E :										
	•	1	2	3	4	5	4	7	8	•	7

TEXT PERM ES BRIDER

JEKA SEKH

12

```
IF THE CLASS IS
 ENTER
 ____
   1
         S. COS. FS, VFS
         LS. LCDS, LFS. LVFS
   2
   3
         SL. COSL. F5L
   4
         VFSL, L. SIL. SI, CL. SICL, SCL
         SC. SIC, c
HUCK, HPT, DE. SP, FEAT. FB, HM, CE, AND TEXTURES WITH
   5
         MK. PT, HODIFIERS
UWB. WB. CEM. IND. MARL. ICE. GYP
         CIND. FRAG, G. SG. AN D ALL MODIFIERS EXCEPT MK, PT, SR
         MODIFIERS
   9
         WAR AND ALL TEXTURES WITH SR MUDIFIERS
 CHOICE FOR TEXTURE 14
 --- RANGES FOR PERMEABILITY ---
 ENTER
       IF THE CLASS IS
 ____
  1
        < .06 IN/HR WITHIN 40" IN DEPTH
         · · · · · · ·
                    (>=.06 AND <.6)
        •6 - 6.0
  3
        4.0 - 20.0
        > 20.0
CHOICE FOR PERMEABILITY: 3
-- RANGES FOR FRACTION > 3 IN ---
ENTER
       IF THE CLASS IS

< 25% IN SURFACE LAYER

        25 - so (>= 25 AND < SO )
  3
        > so
CHOICE FOR FRACTION > 3 IN 1
--- RANGES FOR SULK DENSITY --
ENTER
        IF THE CLASS IS

< 1.2 C/CC ■ITHIN 40" IN DEPTH

  1
        1.2 - 1.5 ( >= 1.2 AND < 1.5 )
        1.5 -1.8
  3
        > 1.8
CHOICE FOR BULK DENSITY : 2
-- RANGES FOR AVAILABLE WATER CAPACITY ---
ENTER
        IF THE CLASS IS
----

∢ 3 TOTAL INCHES TO ∢0"

  1
  2
        3 - 4
              (>= 3" AND < 4",
        4 - 5
  3
  4
       S - 4
  5
       > 6
CHOICE FOR AVAILABLE WATER CAPACITY # 4
--- RANCES FOR K FACTOR ---
      IF THE CLASS IS
ENTER
```

1 ( .15 2 .15 - .24 ( >= .15 AND ( .24 ) 3 .24 - .37 4 .37 - .49 5 > .49

CHOICE FOR K

```
--- RARGES FOR HYDROLUGIC GROUP - - -
 ENTER
       IF THE CLASS IS
   2
         B
        C
   3
        D
   5
        A/D.B/D. OR C/D
 THDITEFOR HYDROLOGIC GROUP:
 YOU HAVE SELECTED :
  1. TEXTURE
                VFSL, L. SIL. SI. C.L. SICL, SCL
                      -6 - 6.0 IN/HR WITHIN 40
  2. PERMEABILITY
     FRACTION > 3 IN 1:25% IN SURFACE LAYER
 3. FRACTION > 3 I N
4. BULK DENSITY
                        1.2 - 1.5G/CC WITHIN 40 INCHES IN DEPTH
     AVAILABLE WATER CAPACITY 5-4 INCHES
     7 FACTOR 5
 7.
 B. DRIGANIC HATTER
                                1 - 4%
 9.
     FLDDDINGFREDUENCY NONE
10. DEFTH OF HIGH WATER TABLE > 6 FT.
11. DEPTH TOBEDROCK > 60 INCHES
W SERIES FOUND
PERMISSIBLE ENTRIES AT THIS POINT ARE &
        *LIST* TO LIST ALL SERIES FOUND
        *AND STATE 接頭經濟
22 AND STATE HT
2 SERIES FOUND
SE LIST
RE BACKUP
TT SERIES FOUND
ES AND STATE ND
TH SERIES FOUND
22 LIST
EMBIDG ( ND0030 )
PARSHALL ( NDOG46 >
FLANTEN ( NDOOGE )
BELF3£LD ( ₩50079 )
BARNES ( #D0119 )
EMRIEK ( NEGIZE )
MEIMPAL ( RD0130 )
FERRAX ( NP0137 >
```

LITTHA ( ND0143 )
TERY ( ND0100 )
BOURELLS ( ND0241 )

## ETTE (SEADEMALS APPLIED FOR)

# UNITED STATES AGRY CORPS OF ENGINEERS ENVIRONMENTAL TECHNICAL INFORMATION STATES

WITER THE STIS MENU HAS BEEN RESTRUCTURED, IN YOU DO NOT SEE YOUR FAUGRITE PAGGRAM HERE LOOK UNDER "MEEN" (97). BAL CORDIN (PH (017) 350-4511 ENT 4437

```
CTIE/EMAT PROGRAM? (TYPE KCR) TO SEE LISTS!
THEEL
 S OR INTRO
                       FOR AN INTRODUCTION TO THE ENVIRONMENTAL TECHNICAL
                               EMPORMATION SYSTEM.
                       FOR THE CHALL'DAMENTAL INVACT CONFUTER-AIDED SYSTEM.
 2 OR E103
                      FOR THE CONFUNCTION OF THE CONFUNCTION OF THE CONFUNCTION OF THE ECONOMIC INFACT FOR CONTINUE TISTEM.
FOR THE AIR TOTAL ENVIRONMENTAL INFACT COMPUTER-ATORD STETEM.
FOR THE INTERACENCY/INTERESPICATAL CODED HATTON FOR
 3 OR CEU25
# OF EIFE
5 OR AFFICS
4 OR TICES
                               EMPIRONMENTAL FLANNING (1100).
2 DR YPER
                       FOR THE EXPERIMENTAL SUPEYSTER HODULE OF ETTE -
                               PILOT SYSTEMS UNIER ZEVELOPHENT.
E OR HELP
• OR RUSCUTS
                      FOR HELP DE USTAG ANY OF THE ETTS SYSTEMS OR UNIX.
S OR RUSCUTS TO IGNORE EXTRANEOUS SHOPE MOISE.
                      TO SEE YOUR MAIL.
LEASE
```

#### STIREWAY PROCRAST (TYPE CORN TO SEE 1357): 7

THE PETROL TO THE

MELCORE TO THE EXPERITINIAL BUDSTSTEM OF ETTS.
THESE ARE PILOT SYSTEMS AND DATABASES WHICH MAY CHANGE DUSCRLY.

```
EPERMENAT PROCEAMY (TYPE (CA) TO BEE LIST):
 TYPEL
  I OR INTED
I GA AIRAD;
                               FOR AN INTRODUCTION TO THE EXPERIENTAL SUPEYEIGHE TO CTIE.
                           FOR THE AIR MODELS.
FOR THE CLEASINGHOUSE SAFORMATION SYSTEM.
  2 OK CHIS
  4 OR 8.15
5 GA SCELDS
                            . FOR THE PRESLING INTORNATION SYSTEM.
                              FOR THE BERNAM CELOS INFORMATION SYSTEM.
  4 C4 TETEIRS
                                FOR EXFERIMENTAL EIFE.
                            # FOR THE POLLUTION ADMITMENT ANALYSIS STETCH.
     GA PAAS
                              FOR THE POLLUTION ABATEMENT ANALYSIS STOTEM.

FOR THE AFLECT LOSER EDITO PRODEL SYSTEM.

FOR THE AFLECT GAINER EDITOR/MODEL SYSTEM.

FOR THE FILOT GAINER HODELS (FORMS AND EROSIOM).

FOR THE SSILE-S INTERPRETATIONS RETRIEVAL SYSTEM.
  # OR LOSEA
  T JR CAIMER
  4 OR BATES
11 ZP $185
12 OR LPEIFS
                                FOR THE LI SCILS-E INTERPRETATIONS ACTRICVAL STETCH.
17 OF CU CELOS FOR THE CIVIL LOFUS CELOS SYSTEM.

17 OF EPA CELOS FOR THE CFO ELLOS SYSTEM.

17 OF APPECAPES FOR THE MATTERNAL POLLUTANT DISCHARGE ELIMINATION SYSTEM -
PERMIT MANAGEMENT SYSTEM.

18 OF APP PARK FOR THE AIR FOLLUTANT ARABETETIN MANAGEMENT STREET.
 THE NATER CAME AFOR THE MATER POLLUTION APARTEMENT MANAGEMENT STATEM.
IS THE MATER THE BIR DUALITY CONTROL SECTION EXSTEN.
2308 AC 21
                               FOR THE BOLLIN CHECKER SYSTEM.
FOR THE HARITUM CONCENTRATION FORMT SOURCE WER HODEL.
.7 PA $168
TO DE FTEAT
TO GR PTETS FOR THE HULTTILE BIETANCE FEINT COURCE AIR HOBEL.
TO GR HAZ MACTE FOR THE HULTTILE BIETANCE FEINT COURCE AIR HOBEL.
TO THE FOR THE CONTROL INFORMATION ACTRIEVAL EXCTEN.
THE COURCE CONTRACTOR ACTRIEVAL EXCTEN.
THE CONTROL WAS CONTRACTOR.
73 08 LUC
74 07 HTM
                              FOR THEOLOGICON OR FICE SYSTEMS.
```

OF THE TO LEAVE THE EXPERIMENTAL HODELS SURSYSTEM OF ETIS. NOT AVAILABLE YET

PERBUHAT PROGRAM? (TYPE CER) TO SEE LIST): 11

20115-5 INTERFRETATIONS RETRIEVAL SYSTEM

A JOINT PROJECT OF USDA SOIL CONSERVATION SERVICE IRIS TROUP

ER LIST

PERHEADILITY

```
-20
                                                                                                 AVAILANE WATER
                                         12
                                                                                                  EROSTON FACTORS
                                        12
                                                                                                 HOIST DULK BENSITY
BOIL REACTION
                                         14
                                                                                                  SALINITY
                                        15
                                                                                                  SHRIME SUELL
                                                                                                MIND ELOSTON GROUP
R MATERIAL " 3 IN PASSING SIEVE MUMBER
                                        16
                                                                                                 ALL THE APOVE TAPLES
                                     ALL
                                    END OR GUIT DE BORE TO CEASE TABLE SPITOR & ALTSCETHER
                                    TABLE ENTAIRS (TYPE CR 24 DONE)
                                    as 1,4.8,*,10,11,12
      UNIT MANE + AUGESE ( MIOSAR )
          0-4 Nº 51L
4-20 Nº 51SL
                                                                                         2-5 \f 10-30 \f 0.6-3.0 \f 0.19-0.22 \f .37\f5 \f 28-35 \f 0.2-0.6 \f 0.14-0.17 \f .32\f \f 38-35 \f 0.2-0.6 \f 0.14-0.17 \f .32\f
                                                                        22
                                                                                                                                                                                                                                                                                                           ۸ı
         20-40 \* $101
                                                                        3.5
      --- SURTINUE ---
         MOIST BULK N'
             (G/C*3)
    CURPENT SERIES : AMESHA ? MTGPOF >
                                TABLE ENTRIES (TYPE CR IF DONE)
                               41 1,4,8,7,10.12
. UNIT PAME & AKESHA ( #TOPOP )
       SEPTH \' \\ OFGARIC \' ELAY \' PERHEA- \' AVAILABLE \' ROIST BULK \' (IN.) \' TEXTURE \' MATTER \' X/SHN \' STLTTY \' MATTER \' DENSITY \' \\ \\ \\ (PCT) \' \\ \\ (SKANA) \' (SKANA) \' (SKANA) \' (SKANA) \'
      0-2 \ $IL \ 2-0 \ $1CL.SIL \ 2-2 \ $ICL.SIL \ 2-46 \ $ICL.SIL \ 2-46 \ $ICL.SIL \ 2-46 \ $ICL.SIL \ 2-46 \ $ICL.SIL \ 2-46 \ $ICL.SIL \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \ 2-46 \
                                                                                                               \' 20-27 \' 0.4-7.0 \\ 0.18-0.70 \\ 1.20-1.40 \\ 20-30 \\ 0.2-0.4 \\ 0.18-0.70 \\ 1.20-1.50 \\ 20-35 \\ 0.2-0.4 \\ 0.18-0.70 \\ 1.20-1.50 \\ 20-35 \\ 0.2-0.4 \\ 0.18-0.70 \\ 1.20-1.50 \\ 20-27 \\ 0.4-7.0 \\ 0.18-0.70 \\ 1.20-1.40
       48-60 N. L.SIL
                                TABLE ENTRIES CTYPE OR IF DORES
   CURRENT BERLES : AMESHA ( MTOSIO )
```

TABLE ENTRIES (TYPE CR IF BONE)

WHIT MANE T AKEEHA ( MIOSOR )

		TENTURE	S	MATTER (PCT)	$\frac{N!}{N!}$	Z:Chm	S	PILITY	X	43TA4 (H1\HI)	V	(E/CH3)	XF.
0-4 6-4 0-4 4-49 49-74	S	r Sir F	N 10 10 10 10 10 10 10 10 10 10 10 10 10	2-5 2-5 2-5	02335	10-18 10-15 10-15 10-25	7777	0.4-2.0 0.6-2.0 2.0-4.0 0.4-2.0 9.6-2.0	2222	0.14-0.20 0.18-0.22 0.11-0.15 0.14-0.17	33333	1.20-1.40 1.20-1.40 1.20-1.40 3.20-1.40 1.20-2.40	¥.

TABLE EXTRIES (TYPE CR IF DONE)

CURRENT REALES : DOUBELLS ( NDOZ41 ) SANDY SUBSTRATUR

TABLE ENTRIES (TYPE CR IF SONE)

GRET RAME : SQURELLE ( NDO241 ) SANDY SUBSTRATUM

SEATH AT TEXTURE AT	M	HATTER (#27)	S	212HH	¥	DILITY	8	MATER (IMPIN)	S	(E/CH3)	M
4-23 NY L-CL	X	2-4	3	18-27 20-35 20-35		0.4-2.0 0.2-0.4 0.2-0.4	S	0.18-0.22 0.14-0.18 0.14-0.18	Ì	1.10-1.40 1.20-1.50 1.30-1.70 1.30-1.70	$\frac{M}{M}$

TABLE ENTRIES (TYPE CR IF DOME)

CHAREST WENTER + BOUDELLS ( MODZOD > FLODDED

TABLE ENTRIES (TYPE OR IF DONE)

THET NAME : BOMBELLS ( NDOZOB ) FLODDED

	V!	TEXTURE	X	487758 48531	S	T COMM	XI	PERREA- PILITY (IM/HR)	$\ddot{\cdot}$	MATER (IH/IH)	X	(6/6#3)	š
6-6	¥.	1.5[L 1,CL	ä	4-4	V	20-24 25-35	S	0.4-2.0		9.17-0.24 0.14-0.23	S	1.10-1.30	57

TRANS EMIRIES (TYPE OR IF BONE)

CHERENT SERIES : PROPELLS ( MD0027 )

```
TABLE ENTRIES CTYPE OR IF DOME!
          ** 0
MAST MAKE & BOUSELLS ( MODDES )
  #EPTH N' Nº DROANIC Nº CLAY Nº PERREA- Nº AVAILABLE Nº HOIST BULK Nº (IN.) Nº TEXTURE Nº HATTER Nº RAZBH Nº BILITY Nº WATER Nº DEHSTTY Nº Nº (IN/HR) Nº (IN/HR) Nº (IG/CH3) Nº
 BEPTH NI
 0-6 \! L,SIL.CL \' Z-6 \1 IE-30 \\ 0.4-2.0 \\ 0.12-0.24 \\ 1.10-1.40 \\ 4-23 \\ L,GL \\ \\ \\ 1.20-35 \\ 0.6-2.0 \\ 0.14-0.22 \\ 1.20-1.50 \\ 23-40 \\ 1.CL \\ \\ \\ 1.20-35 \\ 0.04-0.6 \\ 0.14-0.18 \\ 1.30-1.70 \\
 23-40 \' L.CL
          TABLE ENTRIES (TYPE OR IF DONE)
TABLE OFTION (CR FOR CHOICES) + 4
          ----TYPE 'LIST' OR 'L' FOR A LIST OF CHOICES, TYPE PHELP' FOR HELP,----
          ---- & BERIES AVAILABLE FOR THIS SESSION ----
CURRENT SERVES / AUGGLE / HTGS45 F
         TTPE
                             FOR TABLE SKOULKS
            1
                             BANTTARY FACILITIES
                             CONMUNITY DEVELOPMENT
                             REBOURCE HATERIALS
                             WATER MANAGEMENT
                             RECREATION
         ALL
                             ALL THE ABOVE TABLES
         END OR QUIT OR DONE TO LEAVE TABLE OPTION 7 ALTOGETHER
         USE INTERPRETATION (TYPE CR IF DONE)
         .. 2
    *******
         BEPTIC TANK ABSORPTION FIELDS
         BEVERE - PERCS SLOWLY
         SEWACE LAGODNS
         4-7 2 1
                            MGBERATE - SLOPE
                            BEVERE - SLOFE
         BANITARY LANDFILL (TECHCH)
                            MODERATE - TOO CLATEY MODERATE - SLOPE , TOO CLATEY
         4-8 I r
         2-151 r
        MANSTARY LANDFILL(ASEA)
        4-8 2 1
8-152 1
                           SLIGHT
                            MODERATE - SLOPE
```

```
DAILY COURT FOR LANDFILL
        4-8 7 1
8-157 1
                        FAIR - TOO CLAYEY
FAIR - TOO CLAYEY, SLOPE
        WEE INTERPRETATION (TYPE CR IF DONE)
 CUTRENT SERIES : AMESHA ( 61090+ )
        EST INTERPRETATION (TYPE OR IF DORE)
        1× 2
    ******
        SHALLOW EXCAVATIONS
        SEVELE - METHESS
        BUELLINGS WITHOUT BASEMENTS
        SEVERE - FLOODS
        BUTE-INCS WITH PASTACHTS
        SENTE - FLOODS . UZINESS
        WHALL CONKERCIAL BUILDINGS
       SEVERE - FLOODS
        LUCAL STATETS AND ROADS
       MEVERE - FROST ACTION
       LAWNS, LANDSCAPING, AND COLF FAIRWAYS
       SEVERE - EXCESS SALT
       USE INTERPRETATION (TYPE OR IF BONE)
TURKENT BERIES : AMESHA & MT0528 )
       MEE INTERPRETATION (TYPE OR IF SOME)
       42 3
       BOADFILL
       EDDD
       SAMD
       IMPIDRAPLE - EXCESS FINES
```

**ETAVEL** 

TEFFORNIE - EXCESS FINES

```
TAPSOIL
         FAIR - BHALL STORES
     *******
         UPE INTERPRETATION (TYPE OR IF BONE)
 CURRENT SERIES : SOMBELLS 4 MD0241 ) SANDY SUBSTRATUR
         USE INTERPRETATION (TYPE OR IF BONE)
     ******
         POND RESERVOIR AREA
         POND RESERVOIR

D-3 1 2 MODERATE - SCEPAGE

3-4 1 MODERATE - SCEPAGE , SLOPE
         EMBANKMENTS, DIKES AND LEVEES
         BEWERE - PIPING
        EXCAVATED PONDS-AQUIFIER FED
        SEVERE - NO MATER
        #RAINAGE
         - DEEP TO WATER
        JERICATION
        0-3 % :
2+ % :
                         - EMODEE EASILY
- BLOFE , ERODES EASILT
        TERRACES AND DIVERSIONS
         - ERODES EASILY
        CRASSED BATERNAYS
         - ERDDER EASILY
    *******
        USE INTERPRETATION (TYPE CR IF DOME)
CUPRENT SERIES / BONSELLS ( #00208 ) FLOODED
        USE INTERPRETATION (TYPE CK IF DONE)
        63 5
   ......
       CARP AREAS
       SEVERE - FLOODS
  PICNIC AREAS
```

```
OCCAS . SLICHT
         FREG . MODERATE - FLOODS
         PLAYEROUNDS
         0-2 I DCCAS : MODERATE - FLOODS
2-3 I DCCAS : MODERATE - GLBPI : FLOODS
FREQ : GEVERE - FLOODS
         PATH AND TRAILS
         DCCAS - BLIGHT
FREQ : HODEKATE - FLOODS
         USE INTERPRETATION (TYPE OR IF DORE)
CURRENT SERIES : DONDELLS ( MDD027 )
         MEE INTERPRETATION (TYPE OR IF DONE)
         22 3
         CAMP AREAS
         SELECT.
         PICKIC AREAS
         ST. I CHT
         PLAYERQUNDS
         0-2 Z 1
                            ELICHT
         2-4 1 .
                           MODERATE - SLOPE
         PATH AND TRAILS
         ELICHT
         CEE INTERPRETATION (TYPE CR IF DDME)
PARLE GETTION (OR FOR CHOICES) + *TEREMENT PROJECTOR (TYPE KOR) TO SEE 13579;
CHESTUHAT PROGRAMY CTYPE CON TO SEE LISTED
22VHC12121 4
TRIES MUTTELT VARIANT SEAFCH
         # 6504 SOLL CONSCIPATION SEPULLE INTO SUPSYSTEM DEVELOPED IN
         CHIPEGATIAN WITH THE U.S. ARMY CERL'S ETTS CROUP
        THE CONTEST OF YOU WISH TO LEAVE THE SYSTEM. THE "HELF" FOR HELF.
```

/818/8mvs2

# RERIES MUTIFLE VARIANT SEARCH

W REPR EDIT CONSERNATION PRESICE INTO ERSEABLER DESCRIPTED IN COOPERATION WITH THE U.S. ARMY CERL'S ETIE CROUP

TYPE CONTROL-D IF YOU WISH TO LEAVE THE SYSTEM. TYPE 'HELP' FOR HELP.

#### TE HELP

ENTRY BYRTEY : COMMAND KEY CATEGORY

THE SYSTEM WILL AUTOMATICALLY DETERMINE THE CLASS INTERVAL. YOUR ENTRY IS USED MERCLY TO REFERENCE A RANGE OF VALUES AND AN EXACT MATCH IS USUALLY WOT POSSIBLE.

NOTE : THE CLASS VALUES ARE SAMED ON THE LARCEST MINIMUM VALUES.

BLANK SPACES ARE THE DNLY PERMISSIBLE SEPARATORS IN THE ENTRIES.

#### EXAMPLES .

se FIND PERM 1.2 GET PERKEABILITY RECORD CONTAINING S.2 AS A VALUE

GET RECORD WITH HTDROLOGIC GROUP # BI F MERP 3

GET RECORD FOR COMMON FLOODING PREDUENCY AND AND IT WITH THE PREVIOUS BE GND FLODD COMMON .

RECGED FOUND

44 DR 874TT W

OR THE PREVIOUS RECORD WITH RECORD

#### FE COMMANDS

COMMANDS ±

START WITH THIS RECORD FIND

SAME AS FIND GET STRIES COMBON TO CURRENT AND PREVIOUS RECORDS BET BERIES. IN EITHER ENARCHT OR FREVIOUS RECORDS ED BACK TO PREVIOUS LEVEL - CYSTEM BOCS NOT ALLOW AND BACKUP

CONSECUTIVE PACKUPS SAME AS PACKUP LIST SERIES FOUND COPE 1314

BAME AS LIST RELF MELPI

WĒYS LIST ALL POSSIBLE KEYS COMMANDS.

LIET ALL FOSSIPLE COMMANDS LEAVE THE SYSTEM LEAVE THE SYSTEM TYE DOME

KEYS 1

TYPE

TEXT

PERH

FRACT

BDEN

AUCAP

KFACT

TFACT

DRGH

FLOOD

WATERTE

BEDROCK

HGRF

----

## FIND AWCAP 7

CLASS MINISTE

STATE MOD

. .

ss AND DRGH 1

:: LIST

## LIST

HAND' ( ND0019 ) GILLY ( ND0011 )
BOWFELLS ( ND0027 ,
ESHOND ( ND0031 ,
HAMERLY ( ND0033 ,
TANSEK ( ND0039 )

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#### MAPPING UNIT USE FILE (MUUF)

#### SCS-SOILS-6

Data encoding has been done using many different staffs including; Iowa State University, Technical Service Centers, Contracts, and probably others. Data input has been done by the National Office Soils Staff and more recently the IRIS Staff.

The data has been reformatted and maintained without sufficient staff in the national office. The file is currently being filled with all evailable data. There are now over 100,000 taxonomic records in the file with several tapes from the South and Northeast yet to be processed.

All the data needs updating to standardize SCS-SOILS-6 critical phase terminalogy and match the SCS-SOILS-6 phases with the phases. required on the soil interpretative record SCS-SOILS-S.

It is obvious that a more efficient system is needed. Data input, maintenance, storage and retrieval procedures are being studied and a system is being proposed, but is no: yet approved.

Lata storage and retrievals at Washington Computer Center are currently done by the IRIS Staff. (See example outputs for California)

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# SOIL CHARACTERIZATION DATA PEDON DATA RECORD

Data input and maintenance is done by the National Soil Survey Laboratory Staff, Lincoln, Nebraska.

Data retrieval systems are being tested at the following locations:

- Data retrievals at Colorado State University, Fort Collins, CO, are being tested in the System 2000 Data Base Management System
- Data retrieval procedures at the Uashington Computer Center are being proposed. Retrievals will use EASYTRIEVE and the data in Pedon Data Record format.
- Data retrieval of Pedon site and horizon descriptions in standard block description format is available at the National Soil Survey Laboratory (NSSL) and is being installed at the Washington Computer Center for use by SCS state and technical service center soils staffs via the SCS Harris terminals.
- Computer input of descriptive soil data in the codes used by field soil scientists on SCS form 232q have been tested and utilized by the NSSL staff. This system is being developed for use on the SCS Harris terminals. This same program system has the capacity for key input of characterization laboratory data, mineralogical data, and engineering soil test data using the formats described in appendix IV of the National Cooperative Soil Survey Pedon Coding System
- Input and retrieval of englneering soil test data is being tested for the SCS Harris terminals in the Midwest, South, and Northeast technical service centers and in some states. Tables for internal soil survey use are retrieved in-house on the SCS Harris system Tables for manuscript use are retrieved using the above data transmitted and selected via Harris terminals connected to the Washington Computer Center.

#### SOIL GEOGRAPHIC INFORMATION SYSTEM

The following kinds of map data have been digitized by the SCS Advanced Mapping System (AMS) Staff, Lanham, Maryland.

Detailed Soil Surveys 1:20,000 - 1:24,000

MLRA Mao 1:7,500,000

State General Soil

Association Man 1:500,000

Procedures have been developed to prepare interpretation maps after data attributes have been assigned to the respective Dolygon.

Procedures are being tested by the IRIS Staff to automatically generate attribute files using the mapping unit use file (SCS-SOILS-6) and soil interpretation file (SCS-SOILS-6). This will enable us to display any of the data on the SOILS-5 after typical mapping units have been assigned to the soil associations.

Series: YEGA BAJA TAXONOMY# 347 Date: 8/81 Pedoa No: S61PR-005-001 Taxonomy: liar, mixed, isohyperthermic Aeric Tropaqualfs. Latitude: N18 Deg. 22 Min. Longitude: W366 Deg. 03 Min. Location: FOERTO BICO 210 PICORAS LXP. ST1., 60% NV SO TO FOODS LAS #155: Physicgraphy: in coastal plains Geomosphic Fcaltion: Slope and Aspect: 1 pct Blevetion: Aicrorelief: none žir Temp. Subrer: Zinter: Precipitations Water Table: Not opsgrved Drainage: Schewnat poorly drained Permeability: Stoniness: Land Use: Grassiand or grazing land Erosion or Deposition: Parent Material: Boderately weathered, Barine from sedimentary rock Described by:

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- 11 1d = 33 cm Yellowish brown (10YR 5/3) and darkgrayishbrown (10YR 4/2) gandy loas; weak fine grapular structure; fire, slightly stick:,: slightly plastic; pany fine roots; fine dark colored nodules; abruptwavy boundary.
- 8277 30 43 co Dark quaylah brown (\*078 4/2) and yellowish brown (1078 5/3) sandy loap; a few fine distinct yellowish brown (1078 5/3) eottles; serk coarse supenquiar blocky structure; fire, slightly sticky; slightly plastic; a few fine sagnetic shot concretions; abrupt wayy boundary.
- 2827 43 61 ce Strong brown (7.5YR 5/8) and light gray to gray (57 6/1) sandy loss; bassive structure; firm, sticky: plantic; a few light gray to gray (5Y 6/1) clay exins on vertical faces of peds; fine dark colored addules.
- 83 84 125 cm Brownish yellow (1078 6/8) and light gray (N 7/6) beavy silty clay loss; weak coarse subangular blocky structure; slightly sticky; slightly plastic; a few black (1078 2/3) from-manganese coats on vertical faces of pels; abrupt wavy boundary.
- 69 125 900 cs. Light gray (N 7/0) silty clay; many prominent atrony brows (7.57? 5/d) sortles; sassive structure; sticky; plastic; a few fin coots; abrust wary boundary.

#### RESEARCH AND DEVELOPMENT OF SOIL RESOURCE INFORMATION SYSTEMS

# by Robert D. Heil<sup>1/</sup>

#### **ABSTRACT**

There is universal agreement among natural resource planners that one of their major problems is finding and organizing data that is relevant, valid, and reliable for use in decision-making.

One method for approaching this problem Involves the application of database technology to the development of computerized information systems. Database management technology provides the mechanism through which data can be stored, integrated, and evaluated in many ways so that information can be easily and efficiently delivered to a diverse user community.

A number of hardware and software configurations currently are available for supplying the technological tools needed to address data management needs. Any one, or a number of different hardware and software configurations, may serve as the tool for managing a particular organization's information needs.

However, critical to the development of a successful information system is the need for an in-depth research development program that determines the most effective manner of structuring and integrating data for utilizing database technology. More specifically, research is needed to resolve questions pertaining to data structure, integration, accessibility, security, independence, shareability, reliability, integrity, administration, and other factors as data are managed by a particular hardware and software configuration to meet a particular organization's data management needs.

Professor of Agronomy, Department of Agronomy, Colorado State University, Fort Collins, Colorado 80523.

Development of the Soil Resource Information System (SRIS) was initiated in 1979 under the sponsorship of the Soil Conservation Service, USDA, to address some of these questions.

The research and development approach being utilized emphasizes the following: 1) investigation of user needs; 2) development of a pilot system based on identification of user needs; 3) testing of a pilot system; 4) development of a prototype system; 5) testing of a prototype system; and 6) implementation.

The primary goal of this project is to develop a prototype model which has been sufficiently tested to provide a reliable basis for selecting and implementing a" information system which can serve as a" effective mechanism for delivering soils information to a wide variety of users.

#### Application of a Soil Resource Information System

Tom Priest, Soil Conservation Service, Denver, CO

Colorado Soil Conservation Service, in cooperation with Colorado State University is developing a Soil Resource Information System The information system is being managed by a data base management system (DBMS). The DBMS presently used is System 2000. Other DBMS are being investigated for their applicability and possible advantages. Presently, data from 27 soil survey publications is in the data storage, and is being used to test applications of the system Plans are to develop a system which can be used by any State and Nationally.

Outlines below are some of the immediate and projected applications and advantages of a Soil Resource Information System Most of the examples refer to operations within the Soil Conservation Service. They should apply to other agencies or organizations as well.

This Soil Resource Information System project has demonstrated that a soil information system is a valuable tool in support of activities of the SCS and others who are involved in planning and managing lands.

Soil and related resource information is vital to the environmental decision-making process. This resource has been drastically under-utilized. This is primarily a result of the decision-maker being unaware of the existence of much soil resource information, and access problems to existing information.

Technology exists to ease these access problems. One such technology is the Data Base Management System If this technology is effectually applied to soil information problems, several advantages would result. These include:

# 1. Easy integration among data sources.

Most environmental decisions require the integration of numerous sources of data. Historically, this has been one of the most difficult tasks in the decision-making process. An information system would allow for easy access and integration among data sources. The user can access data from a single source or several integrated sources in a single Interactive session.

### 2. Increased user access.

Most computer-assisted data bases being used today are so sophisticated that the users are a select few who know the system and have enough programming knowledge to access it. Other users with less computer knowledge either have no access or must access the data through other people. Often information requests must be handwritten and mailed to the source. This requires time and restricts the use of the data.

There are primarily two methods of accessing data from a DBMS. The interactive feature allows the user to converse with the data via interactive query and response. This ability to "converse" with the data as new ideas arise improves the decision-making process. The user language provided by the DBMS allows the user with little or no programming skills to structure his queries In a language similar to English.

The second method of access to the system is by writing application programs which access the data via a conventional computer programing language. The more difficult and sophisticated applications would be addressed in this manner.

#### 3. Information availability to remote locations.

The information in SRIS can be accessed from remote terminals via telephone communication. Terminals capable of accessing the data are becoming more readily available at field locations.

#### 4. Increased data integrity.

An information system would increase the integrity of the data available to the public primarily for two reasons: (first) the increased data accessability and usability will improve the correlation process, and (second) data editing and updating are made much easier.

## Teaching and learning tool.

A comprehensive information system will increase our knowledge of soils.

A subset of the data in SRIS is being used by students at Colorado State University in several courses to address land use decisions. The students are given two parcels of land and asked to evaluate these by interacting with the system This experience is new to the students and perceived as a technology which will play an important role in the future.

#### 6. Timeliness of information.

At present, it requires several years from the time of final soil correlation until the soil survey is published and available to users. The data in SRIS could be available within two weeks of finished correlation. The timeliness of other reports could be within hours or at the most a few days.

#### 7. Increased use of soil surveys.

It has always been a goal of SCS to increase the wise and effectual use of information from Soil Survey Reports. The advantages Drovided by a DBMS controlled information system would increase the use of soils data and also support its continued collection.

## 8. Support to the decision-making process.

Many of the problems encountered by environmental decision-makers would be reduced by a comprehensive soil information system Neither this system, nor any other, will eliminate all these problems. or in any way reolace a decision-maker's input. However, it is a step in the direction of providing the decision-maker with the proper tools needed to make rational, valid, and environmentally sound decisions.

Economics and advanced technology in the future will force use of this or a similar system. It will be essential that management carefully review costs, and be prepared to make firm commitments to development, operations, and maintenance of selected systems.

#### Construction of Soils Data base Molokal Island, Rawaii

1. The Cartographic Steff, Soil Conservation Service, Portland, Oragon is currently digitizing Moloksi, Oshu, Lanei, and Maui Islands, Hawaii. The data Will be used to generate shrink-swell, flooding, slope, and dwelling suitability interpretive maps for our state use.

#### More detailed information follows:

- a. Areas cover 1,132,160 acres
- b. UTM 1,000 meter grid used Lo control project
- c. 40 7% quads needed to cover areas
- d. Equipment
  - (1) Nova Mini-Computer, 56K memory
  - (2) Disk-14 million word
  - (3) 19" CRT with Graphics Tablet
  - (4) Wang 9 Track Tape Drive
  - (5) Digitizer Table Surface 38"X50"
  - (6) Plotter Calcomp 960 (wet ink), Plotting Surface 34"X60"
  - (7)Controller (For Plotter) (Model 922)
- 2. The soil information was taken from the finished NCSS publication. 'Soil lines and symbols were compiled to 74' paper quads from a mosaic image with a lot of distortion using a vertical overhead projector. Stable base matte file positives would have been more accurate but they weren't readily available. Soil lines were matched manually between quads.
- 3. Soil lines, publication symbols, and quad nearlines were digitized on our digitizing table, which has a working surface of 38"Z50".
- 4. Each quad was digitized separately and stored on taps, until all quads for one entire island were complete.
- 5. Conversion legends for the various interpretations were then entered into the computer, and the system then produced polygons, and converted the publication symbols to interpretive symbols. The system eliminated all common boundaries produced by conversion from publication symbols to interpretive symbols.
- 6. The quad sheets were inserted into the computer using UTM coordinates. A panelling command was given and all data was automatically joined on the match lines. Any arrors found were flagged by the system and then corrected manually.
- 7. The finished product is a complete interpretive map in one entire piece, with all date matching perfectly.

Prepared by PortlandCarrographic Staff

**USDA-SCS** 

FTS: 423-2831 COM: 503-221-2831

# NCSS MAP FINISHING

#### Introduction

Several agencies are entering into cooperative agreements to accelerate the publication of soil surveys. SCS will usually be responsible for publishing the survey areas, and the lead agencies will be responsible for map compilation, map finishing, and photo reproduction work.

Following are items that are frequently discussed during the various phases of work. It will benefit all parties involved if we give careful attention to these topics as early as possible.

- 1. Determine publication scale before starting any phase of cartographic work.
- 2. Prepare a map of the soil survey area at a scale adequate to show the limit of the soil survey area to an accuracy of 1/4 mile. We recommend using a map scale of 2 miles = 1 inch.
- 3. Determine final map sheet format before starting any phase of cartographic work. Full 7k minute quad format is recommended.
- 4. Prepare a map sheet index and clearly define whether partial maps will be shown as full map sheets, or as insets to other map sheets. Prepare the map sheet index using a copy of the map described in Itam 2 above.
- 5. Select the type of imagery that will be used for the published maps and interim compilation. Some types of imagery that may be used are:
  - 4. Orthophotography
  - b. Single serial photo enlargements (rectified)
  - c. Mosaic of individual serial photos
  - d. Line maps (planimetric or topographic)
- 6. Obtain a 150-line halfrone negative of each map sheet that will be prepared from a photo image. (See a, b, or c above.) This halftone negative must be suitable for lithographic reproduction. It must be repeated (late)

lithogy	raphic reproduc	a, b, or c shove.) tion. It must be a	This halftone ne	gative must be s	uitable for
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1					

Hap compilation and finishing methods should be planned to be capable of reproducing the single line negative mentioned above. This may entail using a wide variety of methods, depending on the individual capabilities of personnel and equipment involved.

- 10. Decide what medium will be used to portray the planimetric detail.
  - a. An existing map similar to USGS map detail
  - b. Ink drafted overlay
  - Scribed image overlay
- 11. When in doubt, check with the SCS Cartographic Staff to evaluate whether your product is suitable for publication. Don't wait until the map finishing is completed.
- 12. Printing topographic information in conjunction with soil lines on an orthophoto image is not advisable. This could require adding an additional color.
- 13. Plan and prepare other miscellaneous material in press-ready form as the detailed maps are completed.

  - a. General Soil Mapsb. Index to Map Sheets
  - c. Conventional and Special Symbols Legend
- 14. Develop a procedure for checking the maps carefully before final negatives are made. This will minimize the need to return the material if we discover errors during final preparation for publication.

D. L. Stelling Read.

# SUMMARY OF

# FOREST SERVICE SOIL

# DATA MANAGEMENT SYSTEM

В

MICHAEL E. YOUNG

and

GORDON E. WARRINGTON

Presented by

**CHUCK GOUOEY** 

February 1982

Watershed Systems Development Group 3825 East Milberry Street Fort Collins, Colorado 80524 (303)482-0356 8-323-1417 A soils data management system is now in the working prototype stage of development. The pedon and mapunit subsystems are operational. The entire system as proposed is shown in Figure 1. The remaining subsystems are proposed for development over the next three to five years.

NFMA direction and Forest Service regulations. This direction necessitates a means of storing basic soils data for use in making interpretations about soil conditions which can then be used for forest planning. Regulations also specify provision for ready retrieval and periodic evaluation of the soil data for accuracy and effectiveness.

The purpose of this system is twofold. First, a soils data base will provide working data for the soil correlation process and support interpretations for forest planning. Second, a data base will allow characterization of soil variables both within the data base and through interfaces with statistical packages. Detailed analysis of large amounts of soil data will enable development and support of management interpretations, provide for grouping of pedons by similar characteristics, and characterization of typifying pedons.

Based on a survey of soil scientists' needs, the pedon and mapunit subsystems were selected for initial development because of general agreement on definitions and standards. Essentially all presently 'collected data can be stored in one of the two subsystems. Figures 2 and 3 show the general structure of the two subsystems. The blocks represent logical groups of components (e.g. there are several parameters that come under the heading HORIZON and are repeated for each horizon in the soil). Pedon and mapunit data logically form the basis on which to make management interpretations. Therefore, it is expected that the interpretations

# FOREST SERVICE SOILS DATA MANAGEMENT SYSTEM

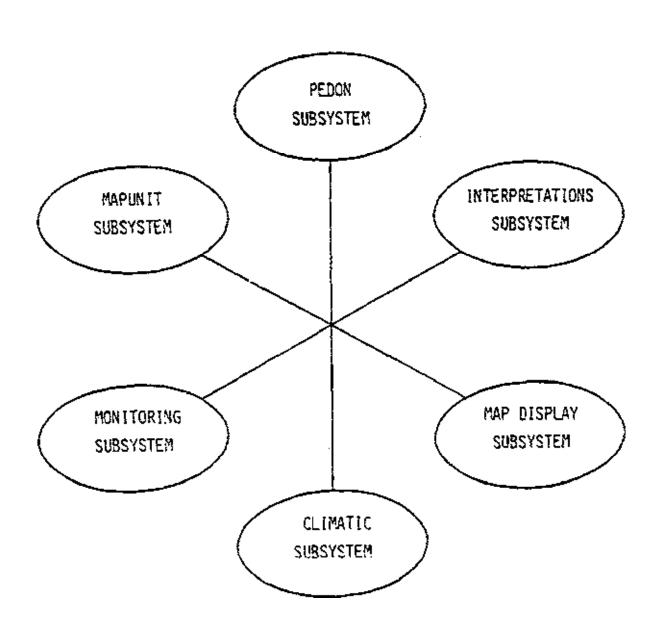


FIGURE 1

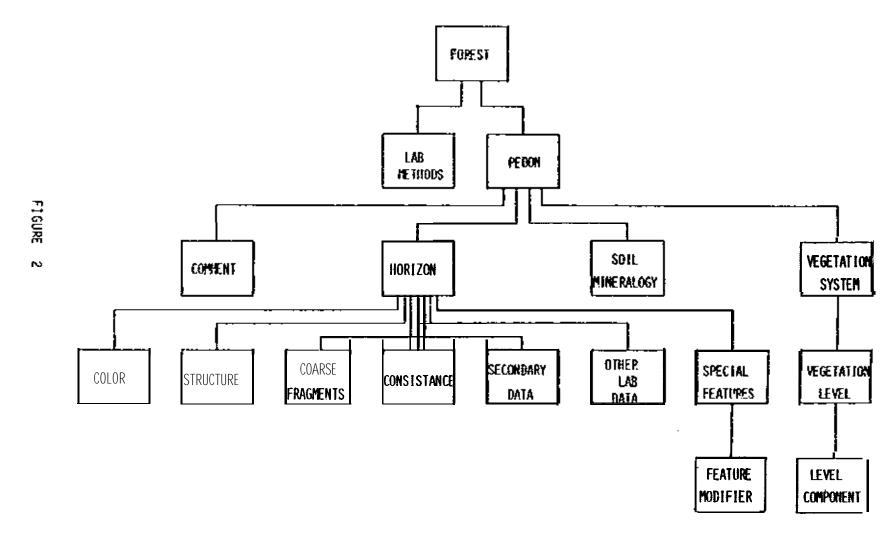


FIGURE 3

subsystem will evolve from analysis and use of the two initial subsystems.

The

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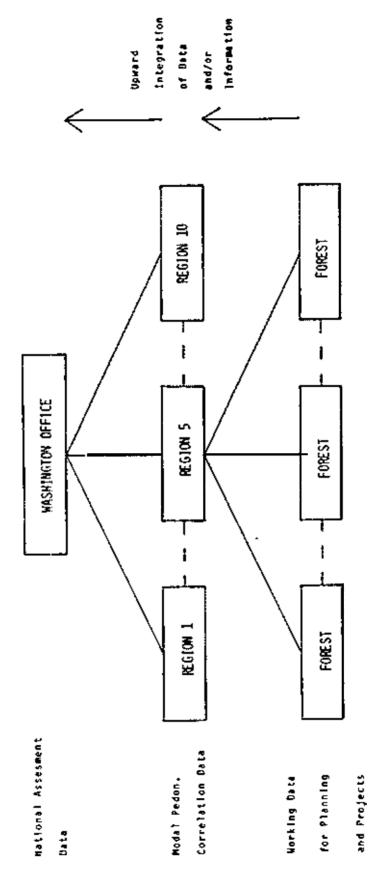


FIGURE 4

# CHARACTERIZATION OF SLOPE CLASSES FOR SOIL SURVEY UTILIZING DIGITAL ELEVATION MODELS\*

Charles E. Henderson and

Stephen D. DeGloria

Remote **Sensing** Research Program
Department of Forestry and Resource **Management**University of California
Berkeley, California **94720** 

#### Presented at

Western Regional Technical Work Planning Conference National Cooperative Soil Survey San Diego, California

February R-12, **1982** 

<sup>\*</sup> Research supported by the National Aeronautic6 and Space Administration Grant #NSG 7220, Office of University Affairs, Washington, DC

# I) BACKGROUND

- 1. Importance of slope information for soil survey, soil interpretations, and soil resource management
- 2. Conventional methods of slope class determination from field survey, photo interpretation, end topographic map interpretation
- **3.** Developments *in* information systems requiring data in a digital format
- 4. Availability of elevation data in digital format
  - a. Digital Terrain Tapes (DTT), Defense Mapping Agency (DMA)
    - digitized 200' contours of 11250,000 topographic quads
    - 1° X 1° geographic coverage
    - 80 m. nominal ground (spatial) resolution
    - cost1 **\$18/1**° quad
  - b. Digital Elevation Models (DEN), Geological Survey-USDI
    - re-compiled from **B&W** 1:80,000 scale, quad-centered aerial photography; 1 meter resolution
    - 71 topographic quadrangle coverage
    - **⊸ 30** m. nominal ground resolution
    - cost: \$18/7½ quad, if available (64-7½'/10quad)

# III) APPROACH

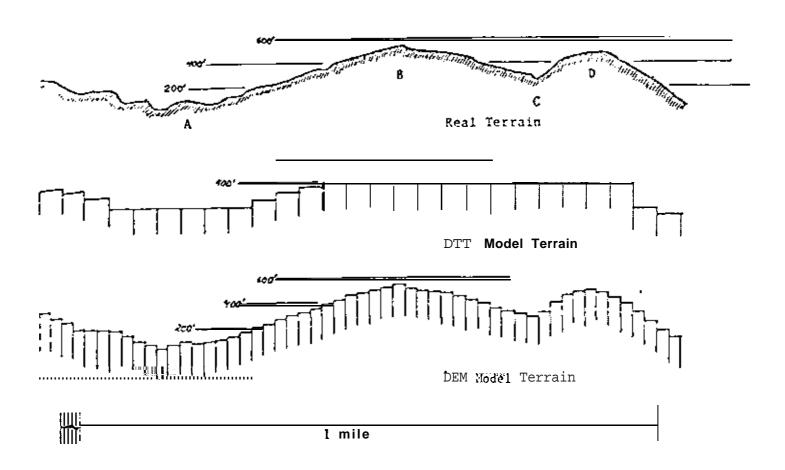
- 1. Select topographic quad for analysis: Willits SE
- 2. Select soil survey area: Mendocino-East
- 3. Digitize preliminary soil map for Willits SE quad
- 4. Obtain DEM data from USGS
- 5. Calculate slope and aspect from DEM
- 6. Combine individual data sets into a multi-component data bank having a 30m grid cell base
- 7. Extract slope values for selected soil map units
- 8. Evaluate visual displays and tabular histograms of slope distributions within each map unit

## IV) RESULTS

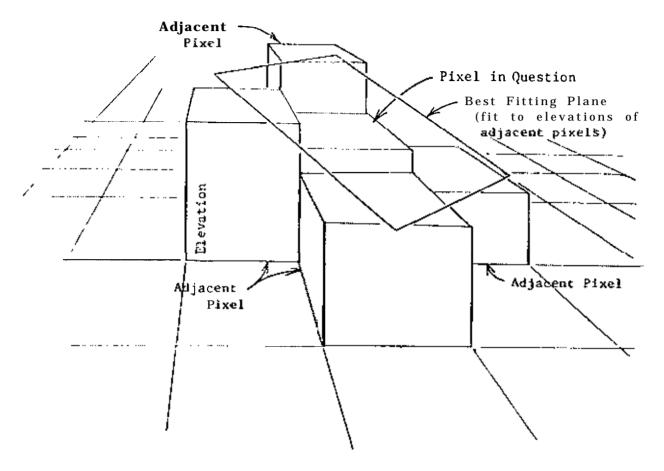
- DELI are an accurate and expensive source of elevation, slope, and aspect data
- Accuracy of slope mapping using DEM is comparable to conventional methods for lower slope classes (< 30%)</li>
- 3. Accuracy of slope mapping using DEM is greater than conventional methods for higher slope classes (>30%)
- 4. Soil interpretations requiring slope information will be more accurate for upland soils if DEM are used as the source of slope information

### V) RECOMMENDATIONS

- 1. At a minimum, use **DEMs** for slope and aspect information, where available, through in-house or service contract computer generation of map overlays
- 2. At a maximum, develop and use **DEMs** for soil survey and soil interpretations for areas not having adequate slope information
- 3. Continue to develop and use computer-based soil information systems for soil survey, interpretations, and management

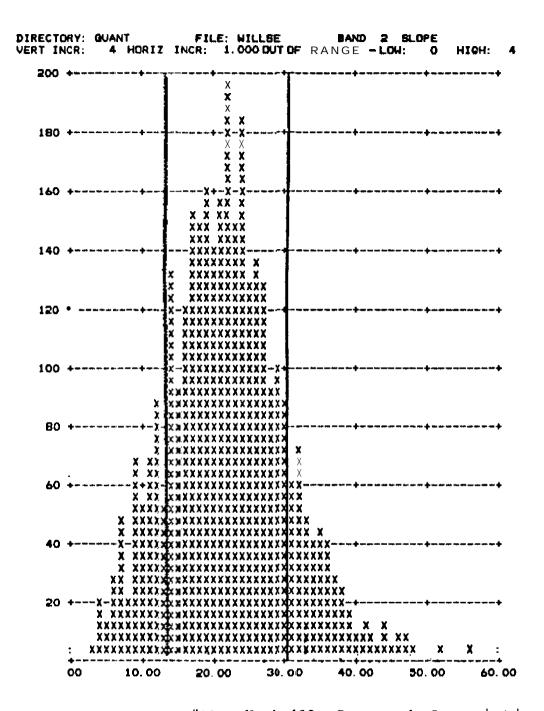


DTT vs. DEM terrain models shown over an imaginary transect. Note that the DTT's interpolation algorithm in some cases truncates mountain tops and fills valleys. By contrast, DEM terrain models represent the real terrain with excellent accuracy.

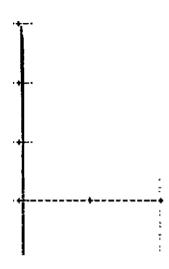


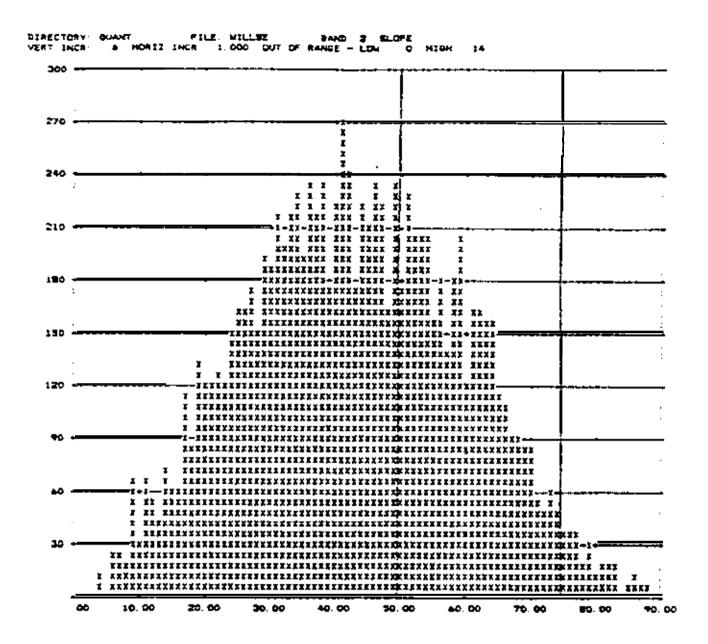
DETERMINATION OF SLOPE AND ASPECT FROM ELEVATION DATA

Slope and Aspect of Best Fitting Plane assigned to Pixel in Question



SOIL #39: Yorkville-Squawrock Association (15-30%)  $(\bar{x} = 22.29, s = 8.85, CV = 39.7)$ 





SOT #25: Naymen-Wooden-Etsel Association (50-75%) (X = 43.02, s = 16.83, CV = 39.1)

# DETERMINING SOIL TEMPERATURE/MOISTURE REGIMES IN FORESTS AND RANGELANDS UTILIZING THERMAL REMOTE SENSING

# Stephen D. DeGloria

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### Presented at

Western Regional Technical Work Planning Conference National Cooperative Soil Survey San Diego, California February 8-12, 1982

Research supported by the Nationwide Forestry Applications Program, Forest Service-USDA Research Contract # 53-3187-1-40, Washington, DC.

#### I) BACKGROUND

- 1. Importance of soil surveys on range and forest land
- 2. Importance of soil temperature and soil moisture regimes in vegetation management
- 3. Importance of remote sensing for characterizing soil climate regimes
  - improved spatial perspective
  - control of measurement error
  - control of sampling error
  - control of systematic variance through land cover stratification
  - allows mapping over large areas based on relationships developed from sample point data

# II) STATEMENT OF THE PROBLEM

- 1. Regional soil temperature and soil moisture regime mapping and estimation are based on atmospheric climate extrapolation
- 2. Atmospheric climate data in western range and forest land are very sparse and variable over small areas
- 3. Soil climate class boundaries have been. developed and calibrated on Great Plains cultivated agriculture
- 4. Limited data sets in the West are not adequate for confirming or modifying existing class boundaries
- 5. Limited remote sensing data exist for correlating land surface variables with soil climate parameters in forested environments
- 6. The relationship between canopy reflectance/temperature and soil temperature/moisture is not well defined
- 7. The relationship between soil temperature/moisture and plant production and canopy cover needs to be determined

#### III) OBJECTIVES

- Determine the equivalence of airborne- end ground acquired canopy temperatures in selected range and forest sites
- 2. Determine the relationship between plant canopy temperatures and soil temperature/moisture distribution and availability
- 3. Determine the relationship between remotely sensed plant canopy temperatures and plant production
- 4. Develop a regional soil temperature mapping system using a remote sensing-based information system

#### IV) APPROACH

- 1. Study area in Plumas National Forest
  - Forest sites: MacFarland Compartment
  - Range sites, Meadow Valley area
- 2. Experimental and Observational units
  - number of sites: 3 timber: 3 range
  - number of plots4 144 approx.; 4 slope aspects/site,
     4 elevation zones/aspect, 3 replicates/zone
  - plot size: 0.1 ha
  - plot shape: rectangular; circular subplots (Method 2)
- 3. Data to be collected
  - water potential, moisture control section; center subplot
  - soil temperature, surface and 50cm; center subplot
  - canopy temperature, °C
  - basal area (forest); peak standing crop (range)
  - land cover characteristics

#### V) POTENTIAL PROBLEM AREAS

- 1. Soil water potential measurements
- 2. Bulk density measurements
- 3. MAST estimation using SMTD

#### VI) PROGRESS TO DATE

- 1. Exploratory field experiments, October 1981 (Appendix)
- 2. Discussions with principal scientists working in research area
- 3. Evaluation of field methods of estimating soil water potential using thermocouple psychrometers

## VII) APPENDIX: Exploratory Field Experiments, Plumas National Forest, October 1981

- Al. Ground Radiometric Data Collection and Evaluation
- A2. October Soil Temperature Sites, Data, and Evaluation

### METHOD 2 - CIRCULAR PLOTS

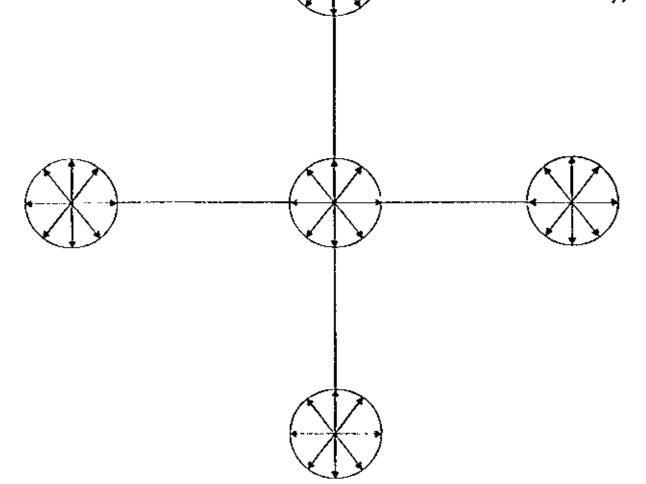
reg cover: grass, shrub, conifer (high density)

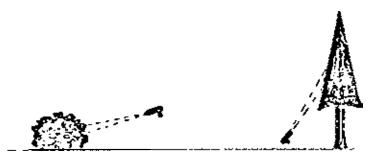
5 subplot/plot

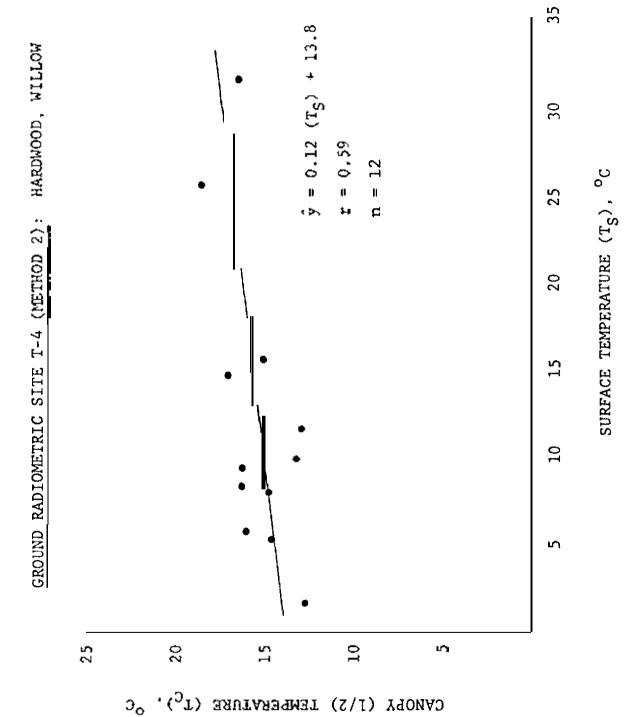
8 pts/subplot

40 pts/plat

15 minutes / plat







#### Preliminary Results

- 1. Method 2 provides equivalent data as does Method 1 but in less time and more efficiently.
- 2. Meadow sites had the greatest surface temperature difference among all other sites between the day and night acquisitions,
- 3. Conifers had the lowest night temperature of the vegetation types present.
- 4. There was no apparent relationship between &-canopy and surface temperature in dense canopy mixed conifer sites,
- 5. \$-canopy temperatures in a hardwood site and a pine plantation were much less variable than the surface readings.
- 6. Airborne **thermal** scanners detected surface temperatures within 1 C for control sites measured coincident with the aircraft overpass (water bodies)
- 7. Use of portable radiation thermometers can be used to estimate soil profile temperatures at 50cm under certain conditions of profile preparation.

#### SOIL TEMPERATURE SAMPLE SITE LOCATION AND CHARACTERISTICS

#### Plumes National Forest

	<u>site</u>	LOCATION	QUAD(15')	ELEVATION	SLOPE	VEGETATIVE COVER (X SHADING)
	01	SW4 9 T25N RILE	Quincy			
#	02	NUL NE 26 226" R 9E	Greenville			
	03	NW 17 T23N R13E	Blaireden			
	04	SW4 NW4 23 T26N R 9g	Greenville			
#	05	NE% NE% 1 T26N R 7E	Almenoz			
	06	NEK 33 T25N R12E	Blairedas			
•	01	SW4 NE4 8 T25N R 7E	Almanor			
#	08	SW4 SW4 7 T25N R BE	Almenor			
	09	NUL NEL 4 223" R 8E	Sucks Lake			
	10	SW4 NE4 2 T23N R BE	Sucke Lake			
	11	SW4 NEW 2 T23N R BE	Sucke Lake			
	12	SE's NE's 31 t24" R 8E	Sucks lake			
	13	NW NEW 31 f24" R 8E	Sucks Lake			
	14	nek 21 <b>123n r 6e</b>	?ulge			
	15	SEK NW 33 T23N R 6E	Fulga			
	16	SUL NUL 7 T24N R 8E	Bucks Lake			
	17	NEK SEK 7 T24N R 8E	Bucke Lake			
	18	NW 18 T26N R14E	Kilford			
	19	NEW 11 T25N R13E	Hilford			
	20	SW4 NEW 17 T26N R12E	Kettle Rock			
	21	SWK NEK 5 T22N R 7E	Bucke Lake			Douglas Fir, Sugar Pine, White Fir (60)
**	22	NEK NEK 17 T26" R12E	Kettle Rock			Panderose Fine, Douglas Fir (30)
*		N₩ 15 T26N R12E	Fettle Rock			Ponderose Pine, Juffrey Pine, S. Pine (60)
	24	erd Area	Jucka Lake			Douglas Fir, White Fir, Sugar Pine (75)
			Kettle Rock			Foodstose Pine, Red Pir, White Fir (70)
			Kettle Rock			Fonderosa Pine, Incense Cedar (30)
			Sucke Lake			Sugar Pine, White Fir (50)
			Sucke Lake			White Pir (65)
			de la constant			Perennial Grasses (meadow site)(100)
			٠ 1			Incense Ceder, Sugar Pine (40)
			<b>`</b> )			Dauglas Fir, Fonderosa Pine (88)
						Lodgepole Pine, Sugar Pine, W. Pir (50)

#### OCTOBER SOIL TEMPERATURE DATA - 1981

Plums National Forest

SITE	T <sub>SS</sub>	OST	SMTD	WS	MOST	MAST	STR
01 02 03 04 <b>05</b>	46.4 46.0 44.6 42.8	40.0 50.6 48.0 48.8 50.1	+3.9 +2.7 +3.5 +2.7 +2.7	Q CD sv CD CD	42.8 52.5 50.5 50.7 52.0	39.1 47.8 46.0 46.2 47.4	F (C)  M  F  M
06 07 08 09 10	40.0 55.4 48.2 37.4 37.4	46.0 57.2 <b>52.4</b> 46.1 47.9	+3.9 +2.7 +2.7 +3.9 +3.9	Q CD CD <b>Q</b> <b>Q</b>	48.8 59.1 54.3 48.9 50.7	44.5 53.0 49.5 44.6 46.2	F (C) M M F F
11 12 13 14 15	44.0 32.9 52.5 50.0 40.6	48.5 42.8 48.2 47.9 46.6	+3.9 +3.9 +3.9 +3.9 +3.9	Q Q Q Q Q	51.3 45.6 51.0 50.7 49.4	46.8 41.6 46.5 46.2 45.0	F F F F
16 17 18 19 20	35.0 40.5 42.0 42.0 36.5	44.0 42.7 48.0 46.0 43.8	+3.9 +3.9 +3.9 +3.9 +3.9	Q Q Q Q Q	46.8 45.5 50.8 48.8 46.6	42.7 41.5 46.3 44.5 42.5	F F F F
21 22 23 24 25	48.0 57.6 47.0 36.0 40.0	44.7 50:3 50.0 40.7 42.0	+3.9 +3.9 +3.9 +3.9 +3.9	Q Q Q Q Q	47.5 53.1 52.8 43.5 44.8	43.3 48.4 48.1 39.7 40.9	F M M F F (C)
26 27 28 29 30	54.0 43.3 38.7 42.0 41.0	50.0 43.0 43.0 44.0 42.3	+3.9 +3.9 +3.9 +3.9 +3.9	<i>Q</i>	52.8 45.8 45.8 46.6 45.1	48.1 41.8 41.8 42.7 41.2	M F F F
31 32 33	43.0 37.5 37.9	44.0 41.0 44.1	+3.9 +3.9 +3.9	Q Q Q	46.8 43.8 46.9	42.7 40.0 42.8	F F F

x=43.1 x=46.4 s= 6.1 s= 3.7 CV=14.2% CV= 8.0%

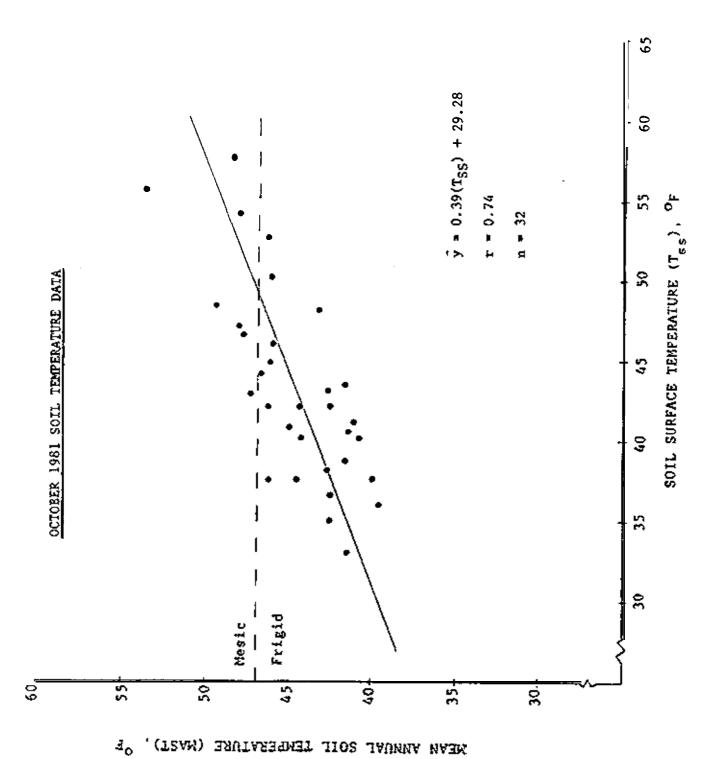
x=49.0 x=44.7 s= 3.5 s= 3.2 CV= 7.1% CV= 7.2%

MAST = 0.44 + 0.903 MOST

MOST = OST + 0.712 SMTD

#### **LEGEND**

- $T_{SS}$  = the soil surface temperature (°F) measured in the 01 horizon.
- OST = the October 15th soil temperature (°F) measured at 20 inches (50 cm).
- smtd = the departure of September mean air temperature from the long-term
  mean for the September of the same year as the OST (°F).
- ws = the closest appropriate weather station from the site of the OST measurement which has recorded the SMTD.
  - CD = Canyon Dam
    - Q = Quincy USFS Heliport
  - SV = Sierraville Ranger Station
- MOST = the mean October soil temperature (OF).
- MAST = the mean annual soil temperature ( ${}^{\circ}F$ ).
- STR = soil temperature regime
  - C = Cryic
  - F = Frigid
  - M = Mesic
- $\bar{x}$  = sample mean,  $\bar{x} = \sum_{i=1}^{n} x_i/n$
- s = sample standard deviation,  $s = \begin{bmatrix} n \\ \sum_{i=1}^{n} (x_i \bar{x})^2 / (n-1) \end{bmatrix}$
- CV = coefficient of variation,  $cv = (s/\bar{x})100$



### Preliminary October Soil Data Evaluation

- 1. Elevation range: 2420 6850 feet
- 2. Slope class ranger 0 65%
- 3. Aspects, all major directions
- 4. Soil temperature range (OST): 40.1 57.2 <sup>O</sup>F.
- 5. MAST Range: 39.1 53.8 °F.
- 6. Soil temperature range (surface): 32.9 57.6 °F.

#### REMOTE SENSING APPLICATIONS IN SOIL SURVEY -

MAP UNIT DESIGN AND QUALITY CONTROL

bу

W. Doug Harrison
USDA - Soil Conservation Service Boise. Idaho

Prepared for

Western Regional Work Planning Conference for Soil Surveys

> San Diego, California February 8-12, 1982

Soil survey mapping in the State of Idaho, and in most western states, is progressing at a rapid rate. This accelerated program has been undertaken in order to meet the immediate soil resource inventory needs of private industry and local, state and federal agencies. In Idaho, to date, 13 soil survey areas are staffed totaling about 20.1 million acres. Mapping is progressing at a rate of about 2 million acres per year of which about 75 percent is of a low intensity 3rd order level. As a result, many new soil types and hundreds of soil mapping units are being developed. It became apparent that soil scientists desperately needed new Innovations in soil survey mapping technique6 to meet survey completion dates and the quality control standards facing them.

Much has been learned in recent years about making low intensity soil surveys to meet accelerated timetables. Specialized equipment such as helicopters, four wheel drive vehicles, motorcycles and power equipment have given soil scientists the ability to map soils at astounding rates. New methods for gathering ground data have been developed to insure that soil mapping units are properly designed to meet the interpretive needs of the user. More importantly, these methods help Insure that the highest quality NCSS standards for mapping are met.

Among less conventional methods, remote sensing has become a cost effective and valuable "tool" for soil surveys. Certainly recent technological advances in aerial photography and remote sensing have helped rekindle the interest to apply the technology to the soil mapping process. There are remote sensing techniques now available to assist the soil scientist to better design low intensity mapping units, accelerate field mapping and improve the overall quality of the soil survey.

The following narrative is based upon what has been learned from applied remote sensing techniques to low intensity soil surveys in Idaho. Two techniques have been tested. These are: 1) the application of Landsat Multispectral Scanner (MSS data) for improved mapping unit <u>delineation</u> accuracy and 2) the application of low altitude vertical aerial photographs for improved map unit <u>design</u> and <u>composition</u>. The techniques were applied to individual soil survey areas representing a unique collection of mapping unit characteristics. Each technique and its application for improved map unit design and quality control is briefly described.

### IMPROVED MAPPING UNIT DELINEATION ACCURACY USING LANDSAT MSS SPECTRAL MAPS

#### W. D. Harrison and M. E. Johnson

#### Background -

In 1979 the Soil Conservation Service entered a contract with Purdue University's Laboratory for Applied Remote Sensing (LARS). The purpose was to test digital Landsat Multispectral Scanner (MSS) data to a third order soil survey in an arid region. The Big Desert Area. Idaho was selected for its unique physiographic nature. In addition, a third order soil survey had just begun in the area establishing a unique timetable to input the MSS spectral data early in the 1980 field season.

#### The Study Area -

The Big Desert Project Area, about 1.2 million acres in size. is located in south central Idaho; part of the Upper Snake River Plain. The area is typified by quaternary lava flows in various stratigraphic layers, each layer having significantly different degrees of soil development. Cinder cones, pressure ridges, calderas, lava flows and rock outcrop are common features that restrict access and isolate areas. The area is typified by a relatively narrow range in precipitation (11 to 14 inches) and elevation (4500 to 6500 feet). However, soil genesis studies indicate more extreme climatic factors once influenced the area.

Vegetation is primarily **sagebrush/bunchgrass.** Crown canopy ranges from 20 to 50 percent depending on condition. **When** disturbed by fire, the sagebrush/bunchgrass type has **been** replaced by dense stands of annual grasses and forbs.

#### Mapping Logistics -

Locating mapping unit boundaries in this area was a primary concern. Third generation negatives were used resulting in relatively low quality 1:24,000 scale quad-centered aerial photographs (soil field sheets) for mapping. The field sheets were adequate for delineating general physiographic features but not adequate for locating subtle changes in relief, vegetative patterns and parent material unique to the area. The soil survey party soon realized that many transects and traverses would be needed to accurately determine mapping unit delineations and unit composition.

#### Acquisition of Spectral Data -

Geometrically corrected Landsat data collected August 23, 1978 were used for the project area. To facilitate analysis procedures, the area was divided into two roughly equal parts, eastern and western. A systematic procedure was used to sample and cluster data representing 2X of the area. The resulting cluster classes were merged until spectrally significant classes representing major land features were determined. This resulted in 22 and 19 separable spectral classes for the eastern and western parts, respectively. The final classification was made using a minimum distance to the mean classification algorithm. Forty-nine spectral maps at a scale of 1:24,000 in units approximating 7 1/2 minute USGS topographic maps were provided to the soil survey party. 1/2

#### Characteristics of Spectral Maps -

Each spectral map was designed to overlay directly over the corresponding 7 1/2 minute topographic map. This made the correlation of topographic maps and soil survey field sheets to spectral maps convenient for field use.

Adapted from the paper "Development of Spectral Maps for Soil-Vegetation Mapping in the Big Desert Area, Idaho;" by Lund, Weismiller, Kristof and Kirschner.

Ad hoc symbols were used to represent each spectral class. Symbols were carefully selected for best visual separation. Clusters of similar symbols (pixels) formed patterns characteristic of significant surface features. Lava beds, for example, were spectrally separable based on surface roughness and amount of vegetative cover.

#### <u>Use of Spectral Maps During Mapping --</u>

Each soil scientist was requested to document the application of the maps in the field. No attempt was made to map directly on the spectral maps. Each of the 49 spectral maps was evaluated as to its usefulness for making map unit delineations. A special "Landsat evaluation form" was prepared.

The majority of the spectral maps proved useful. Each map, when used with the corresponding field sheets, presented the soil scientist with a different perspective with which to view surface features. Many features not visible on the field sheets, such as volcanic ash deposits, changes in relief, and changes in the native plant community, were visible on the spectral maps.

It was not expected that all spectral delineations would represent a soil mapping unit delineation. Areas of high magnitude (reflectance) generally represented disturbance associated with range fires. Careful suggests

In addition the following observations were made:

- 1) The spectral maps offered far more detail (1.15 acre resolution) than was necessary.
- 2) A lens aberation thought to be a unique surface feature on the field sheets was nullified by studying the spectral maps.

#### Conclusion -

The soil survey party unanimously agreed that the quality of the survey area was enhanced using the spectral maps. It gave them another "tool" for improving the mapping unit delineation accuracy of this unique area.

Much has been learned in recent months applying Landsat MSS data to soil surveys. Better methods for stratifying spectral classes have been made through improvements in computer software. Costs per acre for Landsat MSS data have been significantly reduced. The point in time when computer generated Landsat NSS data becomes a standard 'tool' for soil surveys is uncertain. Certainly any additional cost Landsat MSS data may add to a survey can be adequately justified with the improvement in quality control.

### IMPROVED LOW INTENSITY SOIL SURVEY MAP UNIT DESIGN USING LARGE SCALE VERTICAL AERIAL PHOTOGRAPHS

#### W. D. Harrison and K. W. Hipple

I'm sure that most field soil scientists have labored through the map unit design process only to have the correlator question the identified components or even change the soil map unit during the field review process. Transecting soil map units for documentation has been challenging, trying, and frustrating, especially in remote inaccessible areas. A "tool" to supplement map unit design and documentation procedures is available. This tool permits accurate component identification and documents and quantifies soil components where soil differences can be related to vegetation, landform. or topographic feature indicators.

Field sheets for most Idaho soil surveys are 1:24,000 scale aerial photographs. Landscape features or patterns can be recognized during the premapping process but often photo scale restricts actual measurements of the identified features. In most cases, these areas are quantified and supportive documentation is gathered after the soil scientist goes to the field. Only then can percent map unit composition (major and minor components plus inclusions) be identified and transects be completed to document the soil map unit. Transect notes generally take the form of soil observation notes, landscape diagrams, and soil and landscape photographs taken from the most advantageous point - a prominent landscape feature, the ground, or a pickup roof.

A method developed by Dr. Merle P. Meyer, University of Minnesota College of Forestry, can be used to obtain large scale vertical 35mm aerial photographs to study soil, vegetative and miscellaneous land type patterns which may or may not be visible on standard 1:24,000 soil survey field sheets. The large scale vertical 35mm aerial photographs are relatively low cost and can aid soil

map unit design and provide additional documentation for soil map units. The method offers rapid turn-around time **from** the actual photography to a finished usable product (usually 10 to 14 days).

The method uses a 35mm camera system and a portable camera mount which can be attached to helicopters and "high-wing" single engine sircrak. Photo scale can be varied by changing focal lengths with lenses or the platform height above the ground. Stereoscopic overlap can be varied in the flight line by changing aircraft speed and/or exposure interval. Film variety and filter combinations can be used to obtain desired effects. The imagery is typically flown in single line transects. Transect length can be determined by the number of exposures per film roll and the desired amount of stereoscope overlap. These decisions can be approximated during premapping activities.

This method is currently being tested in Idaho. The Custer-Lemhi Area, Idaho Soil Survey contains large acreages of fan terrace landforms which exhibit varying amounts of mound-intermound features. Additionally, these fan terraces have been dissected to varying degrees in response to nearby mountain uplift and runoff during pleistocene glacial events. The areas adjacent to the dissections exhibit varying amounts of windswept vegetation features. Although these areas can be visually identified on 1:24,000 scale soil survey field sheets, the mound-intermound patterns and the windswept features are so complex and small in size that quantification of these features is impossible without actual on the ground measurement.

The previously described method **was** used after field mapping was approximately **80** percent completed in **an** attempt to test photographic technique and map units design with respect to percent composition of mound, intermound, and windswept components.

A Bell B-Z Jet Conversion helicopter with side baskets was used. A motor drive Nikon P2 Photomic 35mm camera equipped with a f/2.8135mm lens. a UV-2A filter, and a remote shutter release was attached to the side basket of the helicopter. Kodachrome 64 transparency (slide) film was used for all transects. Transects were flown at 500 feet and 250 feet above ground level at 60 mph (± 10 mph). This resulted in film scales of 1:1200 and 1:600 respectively, with a 50% stereo overlap.

Map unit component features were observable and measurable from the slides.

Component features were transposed to mylar sheets and measured using a dot grid or a planimeter. Ground transects end slide transparency measurements were compared for soil and vegetation percent map unit composition. In the case of the six transects flown, map unit composition varied by a maximum of 10 percent from the on ground transects established by the soil survey crew.

In 5 of the 6 transects the map unit composition varied by only 2 or 3 percent.

The 10 percent variation occurred because the location selected for the transect was low on the fan terrace where the dissections were more numerous and pronounced and the accompanying windswept component was greater. The overall variance between the flown transects and the on ground transects appears to be within + 2 to 5 percent.

The advantages of the large scale vertical aerial photographic technique for soil surveys are: 1) Soil map units in remote areas can be more thoroughly observed, 2) individual bias in map unit design may be reduced. 3) photographs are permanent records of map unit transects, 4) time spent doing area reconnaissance may be reduced by studying carefully selected photo-transects, 5) extent and component percentages of some map units can be accurately determined as a check to ground transects, and 6) turn-a-round time from actual photography to a finished product is short.

Limitations of this technique include: 1) Aircraft rental is expensive, so careful planning is necessary, 2) no attempt to infer map unit components can be done without adequate field verification; this method is <u>not</u> a substitute for established ground transect procedures. and 3) it must be possible to infer known soil features and vegetative patterns before the interpretation of large scale vertical-aerial photographs for predicting soil taxa is possible.

This method has been in use for several years for making rangeland, riparian and erosion studies. However, the application to low intensity soil surveys is new and unique. It has proven itself very useful in the Custer-Lemhi Area, Idaho soil survey to help solve a unique set of map unit design problems. It is currently being tested in two other soil survey areas in Idaho, one af which is a high intensity (2nd order) survey of agricultural lands. From preliminary results it is already apparent that this method will help improve the mapping unit design and quality control process in survey areas of medium to high intensity.

#### Application of Remote Sensing Landsat MSS Data to Soil Survey Field Procedures in Havasu

#### Robert Roudabush, BLM Phoenix, Arizona

This paper covers the field procedures being used on the Havasu soil survey remote sensing project. Landsat multispectral scanning (MSS) information is beneficial for large survey areas where much of the specific soils information is unknown. The procedures described below are those used for Havasu and ma.y need to be modified for other areas. The Havasu Resource Area is located in the Yuma District, along the Arizona-California border. The vegetation is predominantly Sonoran Basin and Range. The soil moisture regime is aridic and the soil temperature regime is predominantly hyperthermic with some thermic areas in the northeast.

Currently the Havasu SCS and BLM staff are working in the field with the classification products. The field work is scheduled for completion by end of summer 1982. Upon completion of the soil survey a final detailed report will be prepared.

Timing is very important when using Landsat MSS data in that it should be available when the field mapping begins. To achieve the oroper timing, the Landsat MSS data should be stratified and classified during the first year of the survey when the party leader is planning the survey effort. One of the first jobs of the party leader is to determine, with the aid of a range scientist, where the soil moisture and temperature regime breaks occur. The next step is to make the broad landform and parent material breaks, about the detail of a general soils map. These delineations should be recorded as accurately as possible on 7.5 minute USGS tooographic maps or ortho-photoguads. The map base is important in that it must be registered to a UTM grid which is compatible with Landsat data. The accuracy of the lines is also important because it forms the strata from which the spectral classification is performed.

While in the field refining the soil temperature and soil regime lines, study sites should be determined and mapped. In Havasu these study sites are four sections in size. They were used in developing the mapping legend, to learn the soil geomorphic relationships, and to study the reflectance properties of the individual strata. Two study sites were selected in the larger strata to help determine the variability. Once the classification was completed the party leader went to Denver to group the clusters or classes into fewer, more meaningful units.

The final product appears to be useable as the general soils map, with just minor modifications. The product is being used in several other ways. First, to refine the pre-mapping b.y providing more massing unit confidence and line accuracy. Second, it is being used in the field to denote change and infer mapping unit similarities and differences as well as composition. The product also helps in locating large uniform areas where modal nit description can be obtained. This reduces the number of transects needed. It helped locate transition zones as well as different levels of disturbance. The output products aid in transferring the data with more confidence within and between mapping units. The product can also be used to polish the final map.

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FOR SOIL SURVEY February 8-12, 1982 - San Diego, California

Bv

#### Susan Hoffman

#### U.S. Bureau of Reclamation

The importance of irriqated agriculture cannot be overstated. A record \$7.4 billion worth of crops was harvested from lands irricated with water supplied by Bureau of Reclamation projects in 1980. That's enough food to feed approximately 39 million people. Over 27 million acre-feet of irrigation water from Reclamation projects was delivered to 10.2 million acres of land situated in over 148,000 farms throughout 17 Western States and Hawaii.

The Department of Agriculture estimated that total grain exports from the United States in 1980 amounted to 544.5 billion, 20 oercent more than 1979. Although crop production was reduced because of a lack of rainfall throughout much of the Midwest, the South and Plains area in 1980, California experienced a good year. In California—the major fruit, vegetable and nut producers in the United States—farmers harvested \$4.3 billion worth of crops in 1980 with the help of water supplied by Reclamation projects. California led the nation in gross farm receipts in 1980, with nearly 10 percent of the national total from only 3 oercent of the nation's farms.

The United States continues to lead the rest of the world in Droducinq food and exporting food. By suppl. ying food, fiber and agricultural and irrigation technology to many of the third world and developing nations, the United States continues to make significant contributions toward satisfying demands for agricultural production here and throughout the world.

In 1967, at the International Conference on Water for Peace, Charles R. Maierhofer--then the Chief, Division of Drainage and Groundwater Engineering in Reclamation's Denver Office--said of irrigated agriculture, "For the whole world, it is a modern science--the science of survival." A Drime requisite of this science is the development and maintenance of soil zone in which moisture, air and soluble salts are in favorable balance for Dlant growth. Drainage--simply defined as the removal of excess water and excess salts from agriculture

lands--is essential in achieving and maintaining such a balance. History has repeatedly shown that excess water and excess salts must be removed for irrigation to he nermanently successful. Thus, as irrigation has been said to be the science of survival of humanity, it can be added that drainage is the survival of irrigation, and the fundamental measure of the importance of drainage is the benefit orovided by irrigation itself.

Throughout the ages where a civilization needed drainage but did not know of it, their irrigation developments failed. Consequently, the civilization that depended on that irrigated agricultural system also failed. These catastrophes were the result of human and natural forces at work, and they were repeated many times until we learned what caused the failures and how to prevent them Today, although this knowledge is available, it is not widely applied for our benefit.

The Bureau of Reclamation oerforms an irrigation suitability land classification. The purpose of this classification is to define anad characterize land suitability for sustained profitable irrigation. This classification system is a highly specialized land classification defining arable area and is based primarily on economic considerations. The basic economic factors considered include: production capacity, cost of production, and cost of land development. In a specific study area these factors may be influenced by the economic setting, cultural practices, social customs, environmental considerations, irrigation methods, management practices, and others.

Three basic principles are of primary importance in structuring the land classification for a study area. They are: 1) prediction; 2) economic correlation; and, 3) permanent/changeable factors. Under the prediction principle, the classes in the system express the land-water-crop and economic interactions expected to prevail after project development. The economic correlation principle involves relating, within a given setting, the physical factors of soil topography and drainage with associated economic factors. And finally, under the permanent/changeable factors principle, in a given setting there are those land features which will, and those which will not, appreciably be changed under irrigation even though most land factors are changeable at a cost.

Although the actual delineations of land classes in the field are based on physical land characteristics, the mapping criteria which express these differences are developed on the basis of the economic factors. The physical factors of soil, topoqraohy, drainage, climate and water quality of the specific study area must be correlated with economic factors in the form of land classification specifications. These Drovide the quidelines by which lands are mapped for irrigation suitability. As lands are delineated into these various classes through the consideration of land and water characteristics having economic significance in relation to sustained irrigated agriculture, experience has shown that there must be a close staff collaboration between the technical disciplines of soil science, economics, and engineering.

The technical disciplines simultaneously conduct their investigations using existing data when available. However, in most cases, additional field work is necessary because of the level of detail required by Reclamation Droiects. An area which frequently has little existing data is drainage. The Bureau of Reclamation considers drainage a major factor in evaluating land for irrigation suitability and, consequently, the Bureau spends considerable effort collecting drainage data.

In evaluating land for irrigation suitability several drainage conditions must These include surface drainage, drainage of depressions, flooding from offsite sources and subsurface drainage. Subsurface drainage is particularly important because many land having original water tables 20 to 100 feet below the ground surface and with seemingly favorable natural drainage conditions have eventually developed excessively high water tables, leading to Evaluation of internal drainage or drainage waterlogging and salinization. within the root zone is usually the responsibility of the soil scientist, while deep drainage is the responsibility of the drainage engineer. These disciplines work together to develop information on soil characteristics such as hydraulic conductivity, texture, and structure. Information on thickness, position and continuity of the various geologic strata is also obtained. In addition to the normal 5-foot boring used to examine the soil profile, deep borings to 10 feet and greater are also made.

The prime force controlling groundwater levels and salt balance is the movement of water through soil, subsoil, and substrata. Of all the soil characteristics controlling this movement, the one which intearates the combined effects for a particular water and a particular soil type is hydraulic conductivity.

Therefore, the hest information for use in oredicting. analyzing and solving subsurface drainage problems is knowledae of hydraulic conductivity and its expression in quantitative terms. Initially, drainage limits for arable land are based on the hydraulic conductivity of the substrata, deoth to barrier and the location and position of the land.

Bureau of Reclamation investigational and analytical procedures are capable of predicting ultimate drainage requirements with reasonable accuracy. Land which cannot be drained and kept productive at costs within established concepts of feasibility are excluded from the irrigation project area and are deemed not suitable for irrigation.

Among others. salinity and drainage issues have recently received worldwide attention by Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme-Global Environmental Monitoring System (UNEP) and United Nations Educational, Scientific and Cultural Organization (UNESCO) in "A Provisional Method for Soil Degradation Assessment" and "Desertification Control." And, many State and Federal agencies are developing and expanding programs on soil problem assessment, monitoring and control. The demand for soil management support services concerning drainage and salinity control is increasing. But currently, there is no single source ooint of information to serve this need. Since the Bureau of Reclamation has tremendous amounts of substrata, salinity status and drainage data, and since other agencies have complementary data, it would be appropriate for us to make a cooperative effort to bring this data together and make it available to users from a single source.

Perhaps the time has come to include deep drainage and substrata data in our National Cooperative Soil Surveys. This would be especially accordinate in arid and semi-arid regions where irrigation is practiced or where a cotential exists. National Cooperative Soil Surveys usually include Intercretations on irrigation and drainage. SCS-Form 5 contains data on high water tables, cemented pans, and depth to bedrock, as well as noting restrictive features for irrigation and drainage. By including additional substrata data, the usefulness and effectiveness of these interpretations could be enhanced.

#### WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE

of the

NATIONAL COOPERATIVE SOIL SURVEY
San Diego, California

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OPPORTUNITIES FOR EXPEDITING SOIL CORRELATION

by

Richard A. Dierking SCS, WTSC, Portland, Oregon

#### Mr. Chairman and participants:

It is not everyday that a soil correlator is given an obaortunity to expound on the subject of soil correlation to his mentors and peers. So when the chairman asked me to discuss with you the opportunities for expediting soil correlation, I gladly accepted the Challenge to attract your attention. It is my pleasure to be with you here this afternoon to discuss this important subject. I hope Chuck did not equate the importance of the subject with the eleventh place on the agenda for the day.

Soil correlation is a controversial subject. I think the main reason is that it is not well understood--that is, the need for it, the process itself, and the standards we have to guide us.

Before I discuss with you the opportunities for expediting soil correlation, I would like to discuss with you first the process of soil correlation as we practice it today. A discussion of the process will help show, I think, the need for correlation and why we prepared some of standards that we have.

The soil correlation process starts with the recognition of a soil. The soil may occur in a valley or on a mountain too which is not important. What is important is that the soil surveyor recognizes a soil that he thinks is unique and that maybe he should map it. At this point in his deliberation he must make two judgments. First, he must judge the extent of the soil and, second, he must judge its Significance or uniqueness in relation to the

As a practical consideration he knows that purpose of the soil survey area. the extent of the soil should be about 200 acres or about 2,000 acres if he thinks it might be a new one. If the soil is not extensive he will make a record of it in his field notebook for further reference. If the soil is judged to be extensive then he must consider its significance relative to the purpose of the survey. Does the soil have some property that should be recognized because of its importance for its use or management or is it similar to other soils in the area? These judgments as to whether or not a soil is unique and important are very significant and are made everyday by the soil surveyor. Either way he decides, he will set a course of action for If he decides to map the soil he will have to complete eight steos: himself.

- 1. Describe the soil
- 2. Interpret the soil
- 3. Define the soil
- 4. Name the soil
- 5. Design a map unit
- 6. Interpret the map unit
- 7. Define the map unit
- 8. Name the map unit

#### Describe the soil.

The soil surveyor locates the three-dimensional natural body of soil and describes it at several places. He knows that he needs a description of the body of soil and not a part of it. A profile description is two-dimensional so he knows that would be inadequate. One pedon description will not provide the range of values of properties that the body has so he knows that one will not be enough. He realizes that in order to characterize this natural body of soil, that he needs to know its definitive properties, and its observable properties, and its mappable orocerties, and their range in values. He must examine this natural body in several places to find this out. Ideally the body of soil should be about 2 to 3 acres in size. Standard terms are used and formats followed in describing the soil, as it is easier to compare it with other soil descriptions. These terms and formats are found in the National Soils Handbook and Soil Survey Manual.

#### Interpret the soil.

Once the soil is described, it needs to have its oroperties evaluated as to how they behave, resoond or react when the soil is used and managed in wavs significant to the purpose of the survey. An individual property ma.v be important but generally sets of properties should be evaluated. The soil surveyor evaluates those properties that affect a significant soil use or soil management system that are important to the users' needs. Guidelines for soil interpretations are orovided in the National Soils Handbook and hy regional and state offices. The Memorandum of Understanding for the Soil Survey Area will state the purpose of the survey and may also indicate those soil survey interpretations that are needed.

#### Define the soil.

The description and interpretation of one small body of soil will not define a kind of soil. Several bodies should be described. The soil surveyor obtains the descriptions and interpretations of several bodies, then synthesizes the information and prepares a definition of a kind of soil. This definition is known as "the description of a soil as it occurs in the soil survey area." The soil surveyor will not be able to define the soil until several natural bodies of it have been mapped. The number that needs to be mapped before the soil is defined is a matter of judgment of the soil surveyor. The soil may occur as one large body or several small ones. The predicted total acreage of the soil will also affect his decision.

#### Name the soil.

The natural bodies of soil that provide the definition of the soil need to be named. Naming a soil involves identifying or classifying the soil in Soil Taxonomy. The definition of the soil should provide enough information so that the soil surveyor can "key" it through the system. The definitive properties of the soil will identify it as a member of a class of a category. Each class has a name and thereby provides the name for the soil. If the soil cannot be identified as helonging to an established class then the soil must be classified as a new class or the definition of an established class would have to be changed. A name would be orovided to any new class approved for Soil Taxonomy. The class name may have to be modified because the soil may be

managed two different ways in the survey area because of some surface or substratum feature that is not definitive of the class. This is called phasing the class in correlation parlance.

The soil surveyor can embhasize the definitive properties of any class of any category when he initially decides to describe it. That is, he can select the properties of a class in a subgroup. family or series category decending on the properties that are important for the purpose of the survey. Only those properties that are definitive of the class need be emphasized or described. And we include a pedon description for reference and assurance that there is a real natural body in the class. However, the surveyor must remember that each and every natural body in the group being mapped must have the definitive properties of the class.

#### Design a map unit.

After the surveyor has named the soil he must determine how he is qoing to map it. Does it occur generally by itself, or is it intricately mixed with others, or should it be combined with soils that are going to be used similarly? He knows that there are few areas that have 100 percent of one kind of component and that he will have to develop a map unit for the soil. There are four kinds:

- 1. Consociation: dominantly one kind of component.
- 2. Complex: an intricate mixture of two or three components.
- 3. Association: a combination of two or three components that occur near each other.
- 4. Undifferentiated group: a combination of two or three components that do not occur near each other.

A complete definition of each can be found in Chaoter 5 of the Soil Survey Manual.

The kind of map unit that is developed will depend on the kind of components to be mapped as well as the purpose of the survey, the nature of the land and the time allowed for this work.

#### Interpret the map unit.

Map units are designed to be interpreted because they are composed of dominantly one to three major soils. A pure homogenous area of one kind of soil would be easier to plan than one with three kinds of soil. The soil surveyor must determine if the properties of two or three soils collectively affect the planning of the use and management of an area. Each mao unit is unique and has different use and management requirements. Each is designed to provide soil resource information that meets the needs of the user.

#### Define the map unit.

In relation to the purpose of the survey, map units are defined in terms of the kinds, composition, and pattern of their components. The kinds of components the surveyor did or did not recognize, describe, interoret, define and name are considered in the design of the map unit. The surveyor determines the composition and pattern of components in a mao unit during the course of mapping or, if needed, makes special studies. Generally, mao units are a group, collection or set of delineations. Each delineation that is a member of a map unit should have the same definitive characteristics and should be interpreted the same for planning its use and management. There probably is no clear act separating the design, interpretation and definition of the map unit. The surveyor views all these operations as occurring somewhat simultaneously rather than strictly sequentially and they occur while he is examining the soils in a landscape. The correlation of landscape features and the soils assist in the placement of boundaries. The definition of the map unit generally will provide some discussion about its occurrence on the landscape.

#### Name the map unit.

The class names of the components with modifying terms are used to name the map units. The name is unique because the map unit is unique. Naming a

#### Summary of correlation process

Once the soil surveyor recognizes a soil and decides it is worthy of mapping, there are eight steps or stages in the correlation process that need The soil(s) needs to be described, interpreted, defined and named attention. and then for it, a map unit needs to be designed, interpreted, defined and The process is rather straightforward. It certainly is not complicated. Some would divorce the soil Dart from the map unit part, but both would still need to be done. If the steps are followed in the sequence presented, one step will provide information to assist in the completion of the next step. Correlation is nothing more than a comparison process. The soil surveyor compares one soil with others and a map unit with others making sure that each is unique and that each suits the purpose of the survey. Because the same soil can occur in several areas, a correlation is reviewed by one who is familiar with soils in other areas. If one needs a definition of soil correlation, I suggest the following: Soil correlation is a process to scientifically and officially identify soils and approve map units so that soil resource information may be transferred to other areas having the same or similar soils.

#### OPPORTUNITIES FOR EXPEDITING

Expediting means to speed up the progress. Then how can we speed up the progress of the soil correlation process just presented? What opportunities do we have?

There may be ways to expedite the Drocess. Can we eliminate a step or part of one, which would in effect eliminate some time, but may also change the process? Can we combine two steps or Darts of them, and make the Drocess more efficient? Can we train or educate Deople to complete the process expeditiously? Can we Drovide better guidelines so that the process is better understood? Can we provide the means to do the job to those who do not now have the means? Let us examine these possibilities.

#### El i mi nate

Can we eliminate anything?

I might say, somewhat facetiously, that some would like to eliminate the whole process; however, that is not a choice I wish to discuss.

When we look at the eight steps, describe, interpret, define, and name the soil and then design, interoret, define, and name the map unit, we can ask ourselves, "Is there any steo we can eliminate?' How about describing soils? If we eliminate describing soils, we will eliminate the whole process, as soil descriptions are required to complete the other steps. We need soil descriptions. We need descriptions of the three-dimensional natural bodies of soil. They are discrete, although their boundaries may be indistinct. We cannot actually describe the whole body but rather we select several places in the body and completely describe its pedons and then synthesize the information into a description of the natural body--a soil description.

Natural bodies that have the same definitive properties are classifiedtheasis infr (th (described)).

#### Conbi ne

The soil surveyor may be able to combine some map units after testing the mapping of them Standards of use and management criteria for the survey area are needed in order to do this.

Some similar soils may also be combined. This would expedite the soil correlation process because it would take less time to prepare descriptions.

#### Educate

The continuing education and training of soil survey personnel is needed for the effective performance of each step. Staff should review needs of personnel for training and education opportunities. Soil correlation workshops are available or can be set up.

Personnel trained and educated in the soil correlation process will be better able to expedite correlations,

#### Gui del i nes

There are quidelines to help correlators expedite correlations. These should be made available to correlators.

Present instructions for making correlations can be found in the <u>National Soils Handbook</u>. Also, explanations of the process are in the <u>Soil Survey</u> Manual.

A soil surveyor will find the following items helpful:

- 1. List of soils classified in Soil Taxonomy.
- 2. List of the status of soil series descriptions. This list has the date of the most recent soil description and interpretation record.
- 3. Official series description and
- 4. Soil interpretations records
- 5. List of map units used in recent soil surveys in the state.

The above lists and records, except for the official series descriptions, can be developed from data stored in computers in Washington, O.C., and Ames, Iowa. Many computer terminals have access to these data bases and many 'different formats can be developed.

#### Provi de means

Soils should be correlated soon after they have been maoped. The party leader is responsible for correlating soils in his area. If he has the oroper quidelines he can correlate them soon after they have been mapped. He should be provided the quidelines mentioned in the previous section if he does not have them

He should have access to a list of the soils classified in the state, a status list of soil series, appropriate official series descriptions, interpretations records, and a list of map units In adjacent areas.

If the party leader is trained to correlate soils and has the proper tools he should be able to correlate most of his soils. State correlators should be thought of as reviewers of the party leader's correlation. I would like to see party leaders become better correlators as I see this as being the best way to expedite soil correlations.

#### <u>Summary</u>

I hope, from what I have given you this afternoon, you can see that our opportunities for expediting soil correlations are many. They start out in the field with the soil surveyor when he recognizes the first soil in the soil survey area. While the soil correlation process is not complicated, it needs to be completed in steps. Soil surveyors who can complete the steps competently will find that participation in the process is rewarding and worthwhile. Finally, let us remember that:

Soil is aresource.

Soil is anaturalresource.

If it is lost,

It is not renewable in your lifetime.

It is not renewable in a century.

It has value,

Even if you cannot sell it.

Without it,

Plants cannot grow.

RAD 1/82

#### **Northeast Soil Survey Conference**

by Dr. Edward J. Ciolkosz $\frac{1}{2}$ 

Greetings from the cold and snowy Northeast. The reason I am here stems from a meeting that the steering committee (Fred Gilbert, SCS-NY; Ed Sautter, SCS-CT; Ted Miller, NETSC; and Ed Ciolkosz, Penn State Univ.) for the 1982 Northeast Soil Survey Conference held last June. At that meeting the steering committee decided that it should try to foster better inter-regional communication. To help do this we have invited a representative from the other three regions to attend our 1982 conference, which is to be held in Ithaca, New York, on June 20-25. In addition we have solicited conference invitations from the other three regions for a representative from our region. In the remainder of my presentation I would like to briefly give you a rundown on how our conference is run, what we did at our last conference and what we are planning for our 1982 conference.

Up until 1978 we held our conference in New York City in January. At the 1976 conference we decided that there had to be a better place to meet. So we decided to meet in the SUMMER the week before the Northeast American Society of Agronomy Meetings at the same location the NEASA meetings were to be held. The NEASA meetings rotate around the Northeast and are held on university campuses. Our 1978 meeting was held in Connecticut (Univ. of Conn.-Storrs), the 1980 meeting was held in Pennsylvania (The Pennsylvania State Univ.-University Park), and the 1982 meeting is to be held in New York (Cornell Univ.-Ithaca). With our conference's approval the 1984 meeting will be held in Massachusetts (Univ. of Mass.-Amherst). This mode of operation has been well received by our conference. It allows us to have a half day soils field trip, an evening picnic and less expensive housing (university dormitories).

The meetings are made up of the following three parts: 1) General presentations and reports, 2) Committee meetings and reports, and 3) Experiment station reports. The following are the committees for the 1980 meeting as well as the committees for the upcoming 1982 meeting:

#### 1980 Committees

Committee 1, Criteria for Land Capability Classification - Fred Gilbert, Chairman Committee 2. Soil-Wetness Classes and Soil-Water States - Bob Rourke, Chairman

I/Professor of Soil Genesis and Morphology, The Pennsylvania State University, University Park, PA 16802.

- Committee 3, Post Mapping Role of Soil Scientists Art Kuhl, Chairman
- Committee 4, Soil Survey Interpretations made at Categories Above the Series Level Oliver Rice, Chairman
- Committee 5, Evaluating the Adequacy of Older Published Soil Surveys \*\*
  Bob Cunningham, Chairman
- Committee 6, Soil Water Terminology and Hydrologic Modeling Tom Calhoun, Chairman
- Committee 7. General Soils Map and Bulletin of the Northeast Ed Ciolkosz, Chairman
- Committee 8, Northeast Soil Characterization Study Ed Ciolkosz, Chairman

#### 1982 Committees

Committee	1.	Snodosol	Classification	
COMMITTEE		DUUUUSUI	CIASSIIICACIUII	

- Committee 2, Post Mapping Role of Soil Scientist
- Committee 3, Standards and Specifications for Soil Maps
- Committee 4, Improving Descriptions of Map Units
- Committee 5. General Soils Map and Bulletin of the Northeast
- Committee 6, Northeast Soil Characterization Study
- Committee 7, Northeast Newsletter

Robert V. Rourke, Chairman

Robert L. Cunningham, Chairman

Willis E. Hanna, Chairman

Karl H. Langlois, Jr., Chairman

Edward J. Ciolkosz, Chairman

Richard C. Cronce, Chairman

Edward J. Ciolkosz, Chairman

Our conference is, of course, like yours a part of the soil survey activities of the region. The Northeast is much different than your region. Our 13 states encompass an area equal to the combined area of Montana and Wyoming. Being somewhat smaller than the west our soil survey is progressing rapidly. The Northeast is 70% mapped and about 50% of the mapping is published. We have four states (Maryland, Delaware, Connecticut, and Rhode Island) and the District of Columbia in which the mapping is finished. Two additional states are almost finished (New Jersey and Pennsylvania about 98% complete), and the reamining states vary from 77% (Massachusetts) to 43% (Maine) complete. Thus the soil survey in the Northeast is rapidly moving into an era of using soils information as opposed to gathering it (soil mappi ng). This offers many challenges for us today and in the future.

In closing, I would like to say again that my purpose here is to help open better communication between the west and the northeast. In particular, I would like to propose the following:

- 1) We continue with an exchange of conference representatives in the future.
- 2) We exchange directly 10 to 20 copies of our proceedings which can be circulated in our respective regions.
- 3) We explore the possibility of regional newsletters which could be exchanged from region to region.

#### NORTHEAST COOPERATIVE SOIL SURVEY CONFERENCE

#### Keller Conference Center

#### Penn State University University Park, Pennsylvania

June 23 - June 27. 1980

#### **AGENDA**

5:30 - 8:00 p. m	Registration and Social Gatherin	Registration and Social Gathering - Assembly Room Nittany Lion Inn				
Monday, June 23,	1980					
8: 00 - 12: 00 a. m	Registration - Main Desk, First	Floor Keller Conference Center				
8:10 + 8:15 a.m	Opening Remarks (Room 402-403 Conf. Center)	Ed Sautter (Conference Chairman)				
8:15 - 8:30 a.m	Welcome to Penn State University	y James Beattie (Dean of the Penn State College of Ag.)				
8:30 - 9:00 a.m	Soil Survey for the Future	Graham Mınkittrick (State Conservationist SCS - PA)				
9:00 - 9:30 a.m	. International Soils Program	Richard Guthrie (Soil Scientist, Soil Survey and Correlation Staff, SCS, National Office)				
9:30 - 9:50 a.m	Observations from the TSC	Art Holland (Asst. Director NETSC)				
9:50 - 10:20 a.m	Coffee Break	Ground Floor Conf. Center				
10:20 - 10:40 a.m	Soil Survey Program of the Northeast	F. Ted Miller (Head Soils Staff NETSC)				
10:40 - 11:10 a.m	SCS Inventory and Monitoring Program	Jerry Lee (Director, Inventory and Monitor- ing, SCS, National Office)				
11:10 - 11:30 a.m	National Cooperative Soil Survey	Klaus Flach, Deputy Chief for Natural Resource Assess- ment, SCS, National Office				
11:30 - 11:45 a.m	Computer Generated Soil Maps	Gary Petersen (Penn State Staff)				
11:45 - 12:00 a.m	Resource Management Programing System (REMAPS)	Bob Cunningham (Penn State Staff)				
12: D0 - 1: 00 p. m	Lunch					
1:00 - 1:30 p.m	Current and Future Research Activities of the SCS Soils Investigation Program	Ray Daniels (Soil Scientist, Soil Research Coordination, SCS, National Office)				
1:30 - 2:45 p.m	Committee Meetings					
	Committee 1 (Room 405) Criteria for Land Capability Classification - Fred Gilbert, Chairman Committee 2 (Room 403) Soil Wetness Classes and Soil-Water States - Bob Rourke. Chairman					

	Committee 3 (Room 402) Post Mappi Art Kuhl, Chairman	ing Role of Soil Scientists -				
2:45 - 3:15 p.m	Coffee Break	Ground Floor Conf. Center				
3:15 - 5:00 p.m	Committees 1, 2 and 3 continue th	Committees 1, 2 and 3 continue their meetings				
Tuesday, June 24,	1980					
B: 00 - 9:45 a.m	Committee Meetings					
	Committee 4 (Room 403) Soil Survey Interpretations Made at Categories above the Series Level - Oliver Rice, Chairman Committee 5 (Room 405) Evaluating the Adequacy of Older Published Soil Surveys - Bob Cunningham, Chairman Committee 6 (Room 402) Soil Water Terminology and Hydrologic Modeling - Tom Calhoun, Chairman					
9:45 - 10:15 a.m	Coffee Break	Coffee Break				
10:15 - 12:00 a.m	Committees 4. 5 and 6 continue th	Committees 4. 5 and 6 continue their meetings				
12:00 - 1:00 p.m	Lunch	Lunch				
1:00 - 1:20 p.m	The Use of Soils by the Pennsylvania Department of Environmental Resources (PennDER)	Leonard Tritt (Section Chief of the Toxic and Hazardous Materials Section of PennDER)				
1:20 - 1:35 p.m	Spodosol Studies of the Northeast	Ron Yeck (Soil Scientist, National Soil Survey Lab)				
1:35 - 2:00 p.m	Status Report on the Northeast Fragipan Study	Tom Calhoun (Soil Scientist SCS-NETSC)				
2: oo + 2:45 p. m	Experiment Station Reports (15 mi	inutes each)				
	Connecti cut Connecti cut Mai ne	Dave Hill Harvey Luce Bob Rourke				
2:45 - 3:15 p.m	Coffee Break					
3:15 - 5:00 p.m	Committee Meetings	Committee Meetings				
	Conittee 1 (Room 405) Criteria for Land Capability Classification - Fred Gilbert Committee 2 (Room 403) Soil Wetness Classes and Soil-Water States - Bob Rourke Committee 3 (Room 402) Post Mapping Role of Soil Scientists - Art Kuhl					
Wednesday, June 25,	1980					
8:00 - 8:45 a.m	<b>Experiment Station Reports (Room</b>	402-403; 15 minutes each)				
	Maryl and Massachusetts New Hanpshire	John Foss Peter Veneman Nobel Peterson				
8:45 - 9:15 a.m	Report on the 1979 National Co- operative Soil Survey Conference	Peter Veneman				
9:15 • 9:45 a.m	Report on the 1980 Northeast Soil Research Meeting	Peter Veneman				

9:45 - 10:15 a.m

10:15 - 12:00 a.m

Coffee Break

Committee Meetings

Committee 4 (Room 403) Soil Survey Interpretations Made at Categories above the Series LevelCo9393ID (Co931 Committee 5 (Room 405)

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#### Northeast Cooperative Soil Survey Conference Cornell University, Ithaca, New York June 20-25, 1982 Outline of Agenda

#### **General Presentations and Reports**

Soil Surveys of the Past and Future - Paul A. Dodd, State Conservationist

NYS College of Agriculture - David L. Call, Dean, Cornell University

Current Issues - Arthur B. Holland, Director, Northeast Technical Service Center

Technology in Bureaucracy - Ralph J. McCracken, Deputy Chief, Natural Res. Assess.

National Cooperative Soil Survey - Richard W Arnold. Director - Soils

Regional National Cooperative Soil Survey - F. Ted Miller, Head, Soils Staff, NETSC

IRIS Program - George C. Bluhm Director, Integrated Resource Information System

National Soil Survey Lab - Ronald D. Yeck, Liaison to the Northeast

Soil Surveys in Agriculture Value Assessment - Eugene C. Hanchett, Administrator, Soil & Water Resources, NYS Dept. of Ag. & Markets

National Resource Laboratory - Ernest E. Hardy, Director, Resource Information Laboratory, Cornell University

Slide Presentation - "Soil Survey" - Richard D. Babcock

Panel Discussion on Introduction and Presentation of Soil Survey Information - Gerald W Olson, Chairman, Raymond F. Shipp, Tom Simpson, Fred P. Miller

Soil Micro Nutrient Lab Activity - Joseph Kubota, Soil Scientist

Report on National Soil Survey Conference - John C. Sencindiver

Panel - Digitizing Soil Maps - (Members to be named)

Reports from Other Regions and Canada - Regional Representatives

NE Research Committee Report - Robert V. Rourke

Report - Criteria for Land Capability Classification - Frederick L. Gilbert

Tour - Soils and Geomorphology of the Finger Lakes Region - Cornell Staff E Willis Hanna

#### Committees

- 1. Spodosol Classification Robert V. Rourke, Chairman
- 2. Post Mapping Role of Soil Scientist Robert L. Cunningham, Chairman
- 3. Standards and Specifications for Soil Maps Willis E. Hanna, Chairman
- 4. Improving Descriptions of Map Units Karl H. Langlois, Jr., Chairman
- 5. Northeast Soil Map Project Edward J. Ciolkosz, Chairman
- 6. Northeast Soil Characterization Study Richard C. Cronce, Chairman
- 7. Northeast Newsletter Edward J. Ciolkosz, Chairman

#### **Experiment Station Reports**

Connecticut (2)

Mew Hampshire

New Jersey

Maryl and

New York

Massachusetts

New York

Pennsyl vania

Rhode Isl and

Vermont

Virginia

West Virginia

# SOIL SURVEY RELATED RESEARCH AND COOPERATIVE ACTIVITIES OF THE STATE AGRICULTURAL EXPERIMENT STATIONS, WESTERN REGION 1980 - 1982

#### Assembled by G. L. Huntington Chairman WRCC-30

Among the many activities of the Agricultural Experiment Stations of the Land Grant Universities of the western states is that of participation in the National Cooperative Soil Survey. The leaders and representatives from each of the states coordinate their efforts with those of the federal agencies active in soil survey through a Coordinating Committee presently numbered "30" for the Western Region. Members of the Committee also interact with their own state or local agencies active in or associated with soil survey. The contribution and participation of the various states in the national soil survey orogram predates its current organizational identification (WRCC-301 by many decades.

Over this oeriod, the Experiment Stations have been variously active in the direct pursuit of the quals of the Survey. Throughout the life of the Survey, the Experiment Stations have been a direct and active research arm of the Survey, but with each Station directing its portion of the overall effort mainly toward intra-state questions and problems. Within the past decade awareness has been growing among the states of subregional or regional problems related to soil survey that will require a higher level of coordinated regional research. Part of the Committee's function now is to recognize and oropose such inter-state research.

Following is an outline highlighting the Agricultural Exoeriment Stations's research activity relating to soil survey during the period 1980-1982.

- A. Activities common to several states (3 or morel.
  - 1. Field study. sampling, and laboratory characterization of pedons in relation to both standard and special soil surveys. (AZ, CA, HI, IO, NM, NV, OR, WY)
  - 2. Conduct and complete special soil surveys and reports. or compile special purpose soil maps. (CA, CO, IO, MT, NM, NV, UT)
  - 3. Research in soil-land form relationships. (AZ, CA, ID, NV, WY)
  - 4. Research in soil interpretation quidelines and soil suitability for specific uses. (CO, HI, MT, OR)
  - 5. Research in soil climate. (OR, MT, NM, NV1 (All states involved in plan and proposal for a region-wide study)
  - Soil erosion studies in relation to USLE. (CA, OR, WA, UT)
  - 7. Participate in soil survey reviews. (CA, OR, W)

- 8. Computer studies and development of data base structures related to soil survey. (CA, CO, MT)
- 9. Research to develop or improve productivity ratings of agricultural and range soils. (ID, MT, OR)
- 10. Research in pedooenic processes and soil forming factor relationships. (AZ, ID, MT, OR)
- 11. Research in Soil Taxonomy. (HI, ID, OR)
- 12. Studies of remote sensing in relation to soil survey. (AZ, CA, CO, MT)
- 13. Soil survey Work-planning conferences. (All states at various levels of participation)
- 14. Provide services as a soil resource information center. (All states)
- B. Special activities within some states.
  - 1. Soil survey report manuscript review. (CA, OR)
  - 2. Acid rain studies related to soils and vegetation In cooperation with U.S. Park Service. (CA, CO)
  - 3. Soil erosion studies related to crop yield decline. (ID)
  - 4. Studies of development and effects on tree growth of forest soil compaction.
    (CA, MT)
  - 5. Research in soil variability within and among soil map units. (CA, OR)
  - 6. Soil-vegetation relationships. (OR)
  - 7. Benchmark Soils Project in tropical soils; soil taxonomy as a basis for data transfer. (HI)
  - 8. Study of soil-crop management systems in the semi-arid great olains of U.S. and Canada. (CO)
  - 9. Baseline soil, vegetation, geomorphic and hydrologic characterization of a short grass prairie ecosystem (CO)
  - 10. Agricultural rating of soils in a standard survey. (CA)
  - 11. Basic studies of Mt. St. Helen's recent ash In comparison to earlier ash and Mt. Mazama ash. (ID)
  - 12. In-state participation in interagency committee and subcommittees for soil survey coordination. (CA)

#### Publications and Theses of interest to NCSS

#### Ari zona

- Post, D. F. 1981. Relationship of soil texture with soil water content and soil porosity characteristics of Arizona soils. Hydrology and Water Resources in Arizona and the Southwest.
- Horvath, E. H. 1981. Spectral properties of Arizona soils and rangelands and their relationshio to Landsat Digital Data. Ph. D. dissertation. University of Arizona.

(See also aopended report for Arizona.)

#### Cal i forni a

- Scalise, S. 1979. Soil and socio-economic interpretations using an interactive mapping and analysis program for land-use planning at Angel's Camp, California. M.S.+bosis. Dept. of Plant and Soil Biology, Univ. of Calif., Berkeley. 111 a.
- Singer. M.J., J. Blackard, and G.L. Huntington. 1980. Plant cover helps control rangeland erosion. Calif. Agriculture, Vol. 34. No. 10 (Oct.), pp. 8-10, illus.
- Storie, R.E. and W.W. Weir. 1980 (Reprintins). Generalized soil mao of California. (Priced Publ. 4028) Agric. Sci. Publ., University of California, 1422 Harbour Way South, Richmond, CA 94804. 50 P., illus., mao.
- Onofiok, O.E. and M.J. Singer. 1980. The effect of soil compaction on the erosion of three forest soils in California. Report. Univ. of Calif.-Forestt Service Coop. Agreement for Admin. Study. Suppl. No. 26. Dept. of Land, Air and Water Resources, Univ. of Calif., Davis. 132 p., illus.
- McColl, J.G. 1980. Acid precipitation and ecological effects in northern California. In Ecological impact of acid precipitation, D Drablos and A. Tollan (eds.). Proc. Intern. Conf., SNSF Project, Norway.
- Root, J., J.G. McColl and B. Nieman. 1980. Map of areas ootentially sensitive to wet and dry deposition in the United States.
- McColl, J. G. and M.K. Firestone. 1980. Acid orecioitation in Calfornia and some ecological effects. InProc. Symp. "Effects of air pollutants on Mediterranean anbtemperate forest ecosystems."
  U. S. D. A. For. Serv. Gen. Tech. Report PSW 43. p. 242.
- McColl, J.C. 1981. Acid rain in northern California. Fremontia 8:3-S.
- Munn, J. R. and M.J. Singer. July 1981. Relative erodibility of California Benchmark Soils. Land, Air & Water Resources, Univ. of Calif. Davis. 93 p., tables and figs.

- Wardlaw, J. C., E. F. Bullock and E. Beqq. Sept. 1981. Soil database evaluation: a preliminary feasibility study on the development of a soils database for California. Recort. Univ. of Calif. Dept. Cons. Cooperative Effort. Dept. of Land, Air & Water Resources, Univ. of Calif., Davis. 132 p.
- Singer, M.J. Nov. 1981. <u>Seedling compaction studies</u>. Land, Air & Water Res. Papers, No. 10008. Dept. Land, Air & Water Resources, Univ. of Calif., Davis. 80 p., tables and figs.

#### Colorado

- Cole, C.V. and R.D. Heil. 1979. <u>Phosphorus effects on terrestrial</u> <u>nitrogen cycling. In Proceedings of "Terrestrial Nitrogen Cycling Processes Ecosystem Strategies and Management Impacts" Sympos., Sweden. 25 p.</u>
- Anderson, D.W., R.D. Heil, C.V. Cole and P.C. Deutsch. 1980.

  Identification and characteristics of ecosystems at different integrative levels. In Proc. of Int. Sympos. on Nutrient Cycling in Agroecosystems, R. Toad, ed. Univ. of Georgia, Athens, GA.
- Anderson, D.L., K.L. Stevens and R.D. Heil. 1980. An examination of requirements for a soils resource information system. In Proc. Int. Sympos. "Machine Processing of Remotely Sensed Data and Soil Information Systems and Remote Sensing and Soil Survey." Lab. for Applications of Remote Sensing, West Lafayette, IN. op. 259-265.
- Heil, R.D., et al. 1980. <u>Procedures recommended for overburden and hydrologic studies of surface mines</u>. U S.D.A. Forest Service Gen. Tech. Report, INT-71, Interntn. For. and Range Exp. Sta. 106 P.
- Anderson, D. and R.D. Heil. 1981. <u>Important farmlands of Colorado, state summary and mao.</u> Colorado State Univ. Exp. Sta., Ft. Collins, CO. Special Series No. 17. 12 D.

#### Reports:

- Soil Resource Information System Project Report I. Prepared for: U.S.

  Department of Agriculture, Soil Conservation Service. Laboratory for Information Science in Agriculture and Department of Agronomy, Colorado State University. December, 1979.
- Soil Resource Information System Pilot Run Guide. Project Report.

  Laboratory for Information Science in Agriculture and Decartment of Agronomy, Colorado State University. September, 1980. 30 pp.
- Soil Resource Information System Technical Recort No. 1.1. Laboratory for Information Science in Agriculture and Decartment of Agronomy. Colorado State University. January, 1980. 97 pp.

- Soil Resource Information System Project Report No. 2.0. Laboratory for Information Science in Agriculture and Department of Agronomy, Colorado State University. November, 1980. 78 DO.
- SAGORIS Soil and Geologic Overburden Resource Information System
  Project Report 1.0. Laboratory for Information Science in
  Agriculture and Department of Agronomy, Colorado State University.
  March, 1981. 85 PD.

#### Thesis:

Muhaimeed, A. S. 1981. Soil property relationships on selected landscape segments under cultivated vs. rangeland conditions. Ph. D. dissertation. Dept. of Aqronomy. Colorado State Univ., Ft. Collins, co.

(See also appended report for Colorado.)

#### Hawai i

Okimoto, G. 1981. Optimal control for land use decisions in Hawaii - theory and empirical potential. Dept. of Agric. and Resource Economics, Univ. of Hawaii, Honolulu, HI.

(See also appended report for Hawaii.)

#### Montana

(See appended report for Montana Agric. Exp. Sta.)

#### Nevada

- Schmidlin, T.W, F.F. Peterson and R.O. Gifford. 1981. Soil temperature regimes of central and southern Nevada. Extended Abstracts, 15th Conf. Biometeorology. Amer. Biometeorological Soc.
- Peterson, F. F. 1981. Landforms of the basin and range province defined for soil survey. Nev. Agric. Exp. Sta. Tech. Bull. 28
- Schmidlin, T.W 1981. A statistical description of Nevada soil temperatures. M.S. thesis. Univ. of Neveda, Reno.

(See also appended report for Nevada.)

#### New Mexico

- Daugherty, L.A. and B.A. Buchanan. 1980. Soils of the Burnham Lease. New Mexico Aqric. Exp. Sta. Res. Report 408.
- Zobeck, T. M 1980. Soil moisture reqimes along a vegetation transect in central New Mexico. Ph. D. dissertation. Agronomy Department, New Mexico State University, Las Cruces, NM

#### **Oregon**

(See appended report for Oregon State University.)

#### Utah

- Southard, A. R. 1980. <u>Important farmlands of Salt Lake County</u>. Research Report 43, Utah Aqric. Exp. Sta., Utah State Univ., Loqan, UT.
- Research Report 45, Utah Aqric. Exp. Sta.. Utah State Univ., Loqan,
- Exp. Sta., Utah State Univ., Loqun, UT. Utah Science 41(1):21-23.
- Utah Agric. Exo. Sta., Utah State Univ. Logan. UT.
- Southard, R.J. 1980. Comparison of the mineralogy and morphology of some cambic and arqillic horizons in soils of northern Utah. M.S. thesis. Soils & Biomet., Utah State Univ., Loqan, UT.
- Queiroz, J. S. 1980. Genesis of the soil on porohyrv and wiregrass benches, Carbon County, Utah. M.S. thesis. Soils & Biomet., Utah State Univ., Loran, UT.
- Mirsadeqhi, M 1980. Characteristics and genesis of some soils of the upper terraces of Lake Ronneville. M S. thesis. Soils & Biomet., Utah State Miv., Logan, UT.
- paleborolls in northern Utah. Ph. D. dissertation. Soils & Biome., Utah State Univ., Loqun, UT.

#### APPENDED REPORTS

Arizona Colorado Hawaii Montana Nevada Oreqon

#### ARIZONA AGRICULTURAL EXPERIMENT STATION

#### SOIL SURVEY RELATED RESEARCH

#### Summary Report

The use of LANDSAT digital data to assist in mapping Arizona soils has continued. Much of this work is Summarized in a recently (1981) completed Ph. D. dissertation entitled "Spectral Properties of Arizona Soils and Rangelands and Their Relationship to LANDSAT Digital Data" by E. H. Horvath. Two papers on this research have been presented and should be published in the near future.

A project to summarize available laboratory characterization data for the state of Arizona has continued. The coded data  $_{\Lambda}$  being checked for errors.

We are cooperating with the Southwest Watershed Research Center (USDA-SEA) in evaluating the use of a "Microtrac" analyzer for assisting in determining soil texture. This instrument can rapidly perform a particle size analysis of the silt and fine sand (.0019 to .180 mm) size range at one-half phi units. This has potential for providing additional characterization data of pedogenic significance and for soil use interpretations.

Soil Clay mineral analyses (x-ray diffraction) have been performed on soil samples for several agencies, including the Bureau of Land Management, U.S. Geological Survey and the U.S. Forest Service for several National Forests in Arizona and New Mexico.

We are cooperating with the SCS in a soils investigation study of the soils and geomorphology along the Lower Colorado River (Mohave County, Southern Part and Colorado River Indian Reservation). We participated in the Samp-

ling trip and have started some characterization studies to supplement those of the Lincoln Lab. To date, coarse fragment particle size analysis (one-half phi intervals) and clay separations have been completed. Samples are nearly ready for microtrac particle size analysis which should give a good indication of the contributions of aeolian material to the soils. Also planned is a determination of the ammonium oxalate extractable iron and possibly a study of the chemical nature of the desert varnish.

A study of the soils from the Kaibab Plateau (north of the Grand Canyon) is underway in cooperation with the U.S. Forest Service. Fifteen pedons of forested soils representing five vegetation zones have been sampled. The striking feature of these soils is that they are clay rich and generally acid (moderate to strongly acid at the higher elevations) even though they have formed from the Kaibab Limestone. Preliminary x-ray diffraction data indicates that the soil clays contain large proportions of smectite minerals, especially in the argillic horizons. Two pedons of the high elevation mountain meadow soils have also been recently sampled.

A Ph. D. graduate student is working on a weathering study on granite in the Dragoon Mountains in Cochise County. Another student is starting his M.S. thesis research which will involve a study of geomorphic surfaces and pan genesis in an area about 40 miles west of Tucson. There are also several M.S. students with remote sensing-related theses. Included are the use of hand-held radiometers for color determinations. We are also working with several students from the Geosciences Department who have projects involving soils. We assisted one Ph. D. student who is nearly finished with the laboratory characterization of the soils he studied from southern California.

#### Progress Report

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SOIL SURVEY AND RELATED ACTIVITIES
Colorado State University Experiment Station
Department of Agronomy
Period - February 1980-February 1982

#### Personnel:

- R. D. Heil Professor of Soil Science
- J. Cipra Associate Professor of Soil Science
- P. Deutsch Research Associate in Soil Science
- D. Anderson Soil Scientist, Soil Conservation Service, USDA
- C. Yonker Research Associate in Soil Science
- E. Kelly Graduate Student
- R. Aguilar Graduate Student
- A. Mohameed Graduate Student
- M. Walthall Graduate Student
- K. Beaumont Research Technician
- W. Larsen Research Technician

#### Completed Projects:

- 1. Important Farmland Maps have been completed in the last two years for all counties in which important farmlands occur. A summary publication and state map also were published.
- 2. Completed a publication (2 volumes) pertaining to "Procedures Recommended for Overburden and Hydrologic Studies of Surface Mines" for U.S. Forest Service, Intermountain Forest and Range Experiment station.
- 3. A project was completed in June, 1981 by J. Ciprs and co-workers in testing the utilization of Landsat data for identifying impacts of land use on wildlife habitat in selected geographic areas along the front range of Colorado.

#### ongoing Projects:

- Organic Matter and Nutrient Cycling in Semiarid Great Plains of the U.S. and Canadian Prairies. NSF Sponsored. Duration: 5 years. Initiated July 1, 1981. An interdisciplinary study to evaluate the effects of different soil-crop management systems on the organic matter and nutrient cycling (N, P and S) dynamics in semiarid agroecosystems. Results to date are preliminary.
- 2. "CORI" Catalog of Resource Information. A Bureau of Land Management supported study. Will terminate mid-1982. Using the "Powder River Basin" of Wyoming as a study area, available soil resource information was collected and used as a basis to construct a database structure, data dictionary and software for "ad hoc" query in the development of a bibliographic information system pertinent to data needs in reclamation.

- 3. SAGORIS Soil and Geologic Overburden Resource Information System. This project involves a comprehensive feasibility analysis to produce a description of the existing data, data collection, data analysis, and other related activities associated with revegetation and reclamation of lands disturbed by surface mining in the western U.S. This project is being supported by the Bureau of Reclamation, LJSDI, and the work is being performed by the Department of Agronomy and Laboratory for Information Services in Agriculture, College of Agricultural Sciences, Colorado State University. The above analysis, through the testing of a pilot system, will be used to produce a" operational plan for the design and development of a soil and geologic overburden resource information system that will satisfy reclamation planning requirements.
- 4. SRIS Soil Resource Information System.

  This project has been ongoing since 1979 and is a cooperative effort between the Soil Conservation Service, USDA; Laboratory for Information Systems in Agriculture and the Department of Agronomy, Colorado State University. Progress to date includes:

The project is in the second phase for producing a strategy for full implementation of a Soils Resource Information System for the State of Colorado. Currently, **pedon** data, Form-5 data, soil mapping unit data, climatic data, range site data, and soil management data are being investigated in the development, use, and evaluation of a large-scale prototype system to determine the resources required and feasibility for a fully implemented system. Phase 1 included the development of a pilot Soil Resource Information System for demonstration purposes and for identifying **user** requirements and illustrated potential features possible in a full-scale system.

- 5. LTER Long-Term Ecological Research Study NSF Sponsored.

  A five-year project funded January 1, 1982 to develop baseline soil, vegetation, geomorphic, and hydrologic characterization of a short grass prairie ecosystem and identify ecosystem characteristics which should be monitored through time to serve as identifers of significant changes in the system.
- 6. Acid Rain Study An interdisciplinary study funded by the National Park Service. Five-year duration. Initiated January 1, 1982. Aid in developing a simulation model to characterize the effects of acid rain on major ecosystems of Rocky Mountain National Park.

#### Department of Aqronomy and Soil Science University of Hawaii Honolulu, Hawaii

Report to Western Regional Technical Work Planning Conference (NCSS)

San Diego, California

February 8-12, 1982

The Benchmark Soils Project of the Universities of Hawaii and Puerto Rico was established in 1974-75 to test the hypothesis that aqro-production technology can be transferred from one location to another, provided the soils and aqro-ecological environments were similar. Results to date recommend the use of the soil family of Soil Taxonomy as a basis for this transfer. Kinds of aqro-technology transfer are now being compiled by the Project.

A land suitability classification system for irish ootato was developed by using the information contained in the soil family of Soil Taxonomy (L. Manrique, 19821. Land qualities (such as nutrient availabilit.v, water availability, temperature reqime, and so on) of 62 soils were matched with the requirements of the potato crop to develop the system The system also has potential to determine land suitability for other crops.

Soil Taxonomy is continually being tested to improve the system for making better soil surveys and soil interpretations, especially for the tropics. One of the improvements is the proposal of G.D. Smith and the International Committee on the Classification of Andisols (ICOMAND) to reclassify the Andepts Using existing and some new into the new soil order Andisols. data, the 63 Andepts of Hawaii were reclassified (M.R. Recel, 1981). Because new definitions are used in the oroposal, Others include additional laboratory studies are being made. proposals to improve the criteria to classify the Oxisols, Ultisols, and Alfisols. These criteria must also be examined and tested so that the classification of soils is consistent and applicable to present and future land use.

Cooperative work with SCS included the sampling and laboratory characterization of some soils in upland areas of Hawaii being surveyed for the State Division of Forestry for oossible tree plantings and biomass production. One study revealed low nutrient status, high P fixation, and high Al saturation as major constraints in the Tropohumults. Humitropepts, and Tropaquods. Shallow soil depth was also associated with the Tropaquods. Steep slopes or narrow ridges were common landscape features.

## MONTANA AGRICULTURAL **EXPERIMENT** STATION SOIL SURVEY RELATED **PUBLICATIONS** AND PROJECTS DURING 1980 and 1981

This list of publications and projects represents cooperative work with the Soil Conservation Service, Forest Service and Bureau of Land Management in Montana in 1980 and 1981.

#### Soil/State map/Bulletin

<u>Soils of Montana</u>. an Experiment Station Bulletin is in press and is scheduled for distribution along with the state soil map (1:1,000,000 scale) early in 1982.

#### Soil/characterization

Munn, L. C. and G. A. Nielsen. 1981. Computerized processing and storing of soil descriptions and characterization data. Soil Sci. Soc. Am. J. 45:160.

A soil **characterization map** was prepared to show where the chemical, physical and morphological characteristics of nearly 500 soil **pedons** have been investigated and reported.

A two-year investigation (Schafer and Bauman) of permeability of Flathead Basin soils includes evaluation of soil suitability for on-site wastedisposal. Objectives are to develop 1) predictive equations for hydraulic conductivity, 2) a permeability map of the area and 3) computer software to assist in planning for waste disposal.

#### Soil/Remote Sensing

Smith. P. W. 1981. Development of a land cover map from LANDSAT imagery.
M.S. Thesis. Montana State Univ.. Bozeman.

LANDSAT color composite transparencies were visually interpreted to produce an accurate low cost land cover map of Montana. The 1:1,000,000 scale map shows 50% range, 27% forest, 18% dryland\_crops, and 3% irrigated crops. The map was compiled at a cost of \$0.01/km and shows 90% agreement with existing county land use maps.

#### Soil/Geology

Black, J. and C. Montagne. 1981. Geologic field review of Silver Bow County, Montana, for the Whitehall-Butte Soil Survey. Maps and Text. Dept. of Plant and Soil Science. Montana State Univ., Bozeman.

Montagne, C. 1980. A slope stability evaluation method. Abstract With Programs. Rocky Mtn. Section, Geological Soc. of Amer.

properties. This is especially useful **in** identifying opportunities for improving sites damaged by overgrazing.

Soil pedons and vegetation were characterized at about 150 BLM range sites. This is a major on-going project at MSU.

#### Soil/Forest

- Bates, P. C. 1981. Compaction by logging equipment of six soils in northwestern Montana as affected by soil water content, equipment type and number of passes. U.S. Thesis. Montana State Univ., Bozeman.
- Bates, P. C. and L. C. **Munn.** 1981. Compaction by logging equipment of six soils in northwestern **Montana** as affected by soil water content, equipment type, and number of passes. WSSS Abstracts. Eugene, OR.
- Cassidy, E. W. 1981. The effects of mechanized slash piling on soil bulk density and infiltration rates at five forested sites in northwestern Montana. M.S. Thesis. Dept. of Plant and Soil Science, Montana State Univ., Bozeman.

Cullen, S. J. 1981.

#### Soil/Crops

- Ford, **G.** L. and **G.** A. Nielsen. Spring 1982. Environmentally analagous areas: an important concept **in** agronomic research. Agron. J.
- Munn, L. C., B. D. Schweitzer, R. E. Lund, and G. A. Nielsen. 1981. Use of paired sampling to quantify soil productivity. Agron. J. (accepted. Sept. 1981).
- Schweitzer, B. D. 1980. Spring wheat yields on two contrasting Aridic Argiborolls in northcentral Montana. H.S. Thesis dissertation, Montana State University, Bozeman.
- Vech, R. A. 1981. The influence of selected soil physical proerties, soil type and site characteristics, soil temperature, and soil moisture on the response of small grains to potassium on Montana soils. H.S. Thesis. Montana State Univ., Bozeman.

Soil temperature regimes and soil consistence **were** major factors related to wheat yield **response** to potassium **fertilizer** in an investigation of 150 sites in the state. These data may contribute to soil potential ratings.

#### Soil/Reclamation

- Nielsen, C. A. and E. V. Miller. 1980. Crop yields on strip mined lands: a comparison of productivity on native soils vs. strip mine spoils.

  J. Soil and Water Conservation. 35:44-46.
- Schafer, W. M. 1979. Variability of minesoils and natural soils in southeastern Montana. Soil Sci. Soc. Am. J. 43:1207-1212.
- Schafer, W. M., G. A. Nielsen and W. D. Nettleton. 1980. Minesoil genesis and morphology in a spoil chronosequence in Montana. Soil sci. Soc. Am. J. 44:802-807.

#### Soil/Information Delivery

Storage and retrieval of soil pedon descriptions and laboratory data is accomplished with microcomputers and programs developed by Schafer.

Microcomputers were purchased for all agricultural research centers as a part of a statewide agricultural information network. Interactive, problem-solving programs are available from several other states through AGNET. Several programs are related to soils and land planning but few use soil survey information directly or consider soil conservation problems. Increased use of soil survey data is anticipated in these models thereby providing more "personalized" management recommendations. However, the large size of soil survey data bases continues to limit applications in interactive models.

#### 1982 **WRCC-30** Biannual Meeting San Diego, California February 11, 1982

Summary of Soil Survey-Related Activities, 1980-82

NEVADA

F.F. Peterson, Nev. Agr. Exp. Sta.

- --Completed a first approximation map of mean annual soil temperatures (MAST) for Nevada at 1:250,000 scale. The map was constructed using an equation for MAST as a function of elevation and latitude that was developed from state-wide soil temperature measurements for two to five-year periods for various parts of the state during a ten year period. The initial map suggests sub-divisions of the soil temperature regime classes are needed to fit natural vegetation, and that too many interpretations for vegetation may have been loaded on soil temperature.
- --Completed and distributed Technical Bulletin 28, "Landforms of the Basin and Range Province--Defined for Soil Survey".
- --Led five, one-day field training sessions for soil surveyors on identification of landforms and geomorphology.
- --Participated in a WRCC-30 effort for a proposal for regional research on "soil climate" and range and forest vegetation; the proposal has been submitted for approval by the western Experiment Station Directors.
- --Participated in a Nevada "Govenor's Review Committee, Agriculture/Farming, for the Draft MX Environmental Statement" with special attention on my part to map display and soil resource evaluation validity.
- --Participated with SCS in one soil characterization sampling trip and one sampling trip for a soil nitrate accumulation study.
- --Wrote a historical review of the "Kinds of Soil Surveys" classification for the 1982 Western Regional Work Planning Conference for Soil Survey.

January 28, 1982

Oregon State University Report to **Western** Region NCSS Technical Work Planning Conference, San Diego, 1982. - G. H. **Simonson** 

We have continued participation on many of the <u>field reviews</u> of soil surveys throughout the state in cooperation with SCS, **BLM, USFS,** and **BIA,** and have reviewed <u>manuscripts</u> of the completed survey reports. Sampling and <u>laboratory characterization</u> of selected soils were conducted in most survey areas.

Soil temperature data are being collected by Field Soil Scientists in survey areas throughout the state. These data are being analyzed to establish parameters of soil temperature regimes and relationships to natural vegetation. The coastal fog belt is now being recognized as iso-mesic.

Soil Temperature and Soil **Moisture** regime maps will be developed for Oregon from the present data base and field estimates. These will be used to revise boundaries on the present draft of the State General Soil Map and allow early (we hope) completion of the map and report.

A nearly completed M.S. thesis by David Green has measured <u>soil temperature interactions</u> between <u>aspect and canopy cover</u> at elevations of <u>one to four thousand feet</u> in the interior Western Oregon Coast Range. **Soil** temperature regimes are **mesic** below 2500'; at 2500' the north-closed canopy is cryic and north-open is frigid; at 3000' south-open is mesic, both north and south-closed are frigid, and north-open is cryic; above **3000'**, all sites are cryic.

Characterization data and Engineering behavior were obtained for <u>Vertisols</u> and <u>Clayey Mollisols</u> in Douglas Co., S. W. Oregon, to develop relationships of soil properties and performance of these problem soils. Local people were asked to describe <u>problems</u> in use of these soils and means employed to overcome limitations in their use.

A scheme has been devised to develop <u>productivity ratings</u> for Western Oregon Soils, based on **taxonomic** nomenclature, with adjustments for needed amendments, drainage and irrigation.

A model to identify <u>agricultural suitability</u> of land parcels in western Oregon combines soil <u>productivity ratings</u> and <u>compatability ratings</u> with adjacent land uses as an aid in local land use planning decisions.

Report to Western Region NCSS Technical Work Planning Conference January 28, 1982 Page 2

<u>Soil variability</u> was determined for two <u>map units</u> of the Rogue River NF Soil Resources Inventory. Statistical analysis showed <u>chemical properties</u> were <u>more variable</u> than physical or morphological properties. <u>Most variability occured within</u>, rather than between <u>delineations</u>, and most properties were as likely to change at 15 foot intervals as at 660 feet intervals.

A second study of variability — on a map unit of a detailed soil survey in the **Willamette** Valley foothills — showed a <u>0% taxonomic purity</u>, although 69% of the sample sites could be <u>considered similar</u>, or less limiting than the named phase, for use and management.

Another study is in progress on <u>variability</u> in <u>coarse fragments</u> and other properties affecting <u>water supply</u> to <u>tree seedlings</u> in steep, forested land.

We continued a comparative study of <u>soil - vegetation relationships</u> on sites representing distributions of three <u>big sagebrush subspecies</u> in S.E. Oregon. Soil sampling and <u>infiltration - erodibility</u> tests using a Rocky Mountain **infiltrometer** were completed.

A study of <u>clay mineral genesis</u> was completed for soils representative of several geomorphic <u>surfaces</u> ranging in <u>age</u> from <u>Plio-Pleistocene</u> to <u>late Pleistocene</u>. Soil <u>solution</u> studies, <u>clay mineralogy</u> and soil <u>micromorphology</u> including <u>SEM</u> and <u>TEM</u>, were employed to obtain evidence of clay mineral <u>synthesis</u>, <u>alterations</u> and <u>equilibria</u> in this Ph.D. thesis study by Reed <u>Glasmann</u>.

<u>Andepts</u> and <u>andic</u> intergrade soils of the Coastal zone are being studied by <u>morphological</u>, <u>chemical</u>, <u>physical</u>. and <u>mineralogical</u> analyses for a Ph.D. study by **Rodrigo** Badayos. <u>Criteria</u> of the proposed <u>Andisol</u> order are being tested.

A soil <u>bio-climosequence</u> from loess and <u>ash</u> in the <u>Blue Mountains</u> of N.E. Oregon is the basis for an M.S. **thesis** study by Brad Berggren.

#### Approved Theses and publications:

- Rogers, W. R. 1980. A Model for Rating Agricultural Suitability of Land Parcels in Western Oregon. M.S. thesis, Oregon State Unviersity Library.
- Wicherski, Bruce. 1981. Analysis of Variability of Some Forest Soils in Southwestern Oregon. M.S. thesis, Oregon State University Library.
- Kastens, Marilyn. 1981. Soil Variability of a **Willakenzie** Map Unit in **Yamhill** County, Oregon. M.S. thesis, Oregon State University Library.

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- Glasmann, J. R., and G. F. Kling. 1980. Origin of Soil Materials in Foothill Soils of Willamette Valley, Oregon. Soil Sci. Soc. Am. J. 44:123-130.
- Glasmann, J. R., R. G. **Brown** and G. F. Kling. 1980. Soil Geomorphic Relationships in the Western Margin of the Willamette Valley, Oregon. Soil Sci. **Soc.** Am. J. **44:1045-1052.**
- Glasmann, J. R. 1982. Alteration of **Andesite** in Wet, Unstable Soils of Oregon's Western Cascades. Clays and Clay Minerals (in press).
- Glasmann, J. R. and G. H. Simonson. **ca** 1982. Interrelationships of Clay Mineralogy, Soil Solution Chemistry, and Landscape Age in Soils of Western Oregon. Soil Sci. **Soc.** Am. J. (submitted).

#### BUREAU OF INDIAN AFFAIRS SOIL SURVEYS

The Bureau of Indian Affairs has a very limited soil survey capability with the majority of the field soil scientists being in the Albuquerque, Navajo, and Portland areas. Our soil survey activities are shifting more toward interpretations for determination of potentially **irrigable** lands for use in determining water needs for irrigation. In several instances the data has been or will be used in general adjudication of water rights for specific watersheds.

Most of our on-going soil surveys are being accomplished through Interagency Agreements or by contract. We have a unique soil survey in progress on the Yakima Reservation in Washington, where the water rights in the Yakima **River** basin are being adjudicated. We are making a standarad soil survey for general resource management purposes and at the same time gathering enough additional data to make an irrigation The irrigation classification will be used suitability classification. in the ligitation and for long-range irrigation project planning and the standard survey will provide soils data for general resource8 management purposes. The survey has been contracted to the Yakima Tribe, which has hired a staff of Soil Scientists, Laboratory Technician, and Cartographic Technician. We anticipate that upon completion of the soil survey on the Yakima Reservation the soil survey team may be available to perform soil surveys under contract on other reservations or for others needing soil surveys. We expect to complete the Yakima survey in 1985.

The Bureau of Indian Affairs is in the process of analyzing the feasibility of utilizing digital geographic information systems for analysis of natural resource inventory data, including soils, to determine the benefits and costs of storing our data in an automated system to make it more useable. We are running a test on the U. S. Fish and Wildlife system at Fort Collins, Colorado with data from the Hoopa Reservation in California.

Donald R. Jones
Area Soil Scienties

Western Regional Technical Work Planning Conference of the National Cooperative Soil Survey San Diego, California February 8-12, 1982 Jack C. Chugg

The Bureau of Land Management appreciates the opportunity to participate in this, our second conference, and report to **you** on our soil survey activities. In 1980, here in San Diego, all the Bureau's State Soil Scientists were present. The only change in the State level staff is that Han Yee returned to the SCS and Rob Roudabush is now the State Soil Scientist in Arizona.

#### Cooperative Soil Survey

A Memorandum of Understanding for soil surveys on the public lands that the Bureau of Land Management (BLM) manages was signed by the BLM and the Soil Conservation Service (SCS) in 1978. At that time, the BLM had about 32 million acres mapped that met the Bureau's requirements for soil information. Since 1978, the Bureau, in cooperation with the SCS, has reported about 55 million acres of soil surveys that meet the standards of the National Cooperative Soil Survey. We now have about 87 million acres completed or about 50 percent of the total area that the Bureau manages in the Western United States. Soil surveys are a priority item in the Bureau now and in the foreseeable future.

The Bureau will continue to support the soil survey program at the 1981 level for fiscal years 1983 and 1984. Our target date for completion of the soil survey is 1989. To do **this** will require close coordination and cooperation with the Soil Conservation Service.

#### Soil Survey Management

A draft Manual Section 7100 Soil Management was prepared by the Washington Office during 1981. It is intended that this Manual Section will become a supplement to the National Soil Handbook (NSH) when approved by the Bureau. Plans have been made to complete the Manual Section in fiscal year 1982.

The Bureau's new Grazing Management Policy will have an effect upon the soil survey program. It has a requirement for Order 3 soil surveys and the soil information it provides in order to implement the policy over time. The Long Range Soil Survey work plan will be updated in the third quarter of fiscal year 1982. This will be necessary to develop a basic soil program funding level for future budget formulation purposes.

#### Special Projects

The BLM's Lake Havasu Resource Area has a soil survey being conducted by the Soil Conservation Service that is using Remote Sensing as a tool in mapping. The Bureau's Denver Service Center is supplying the technology to do this work. The project has been in progress for about 1 year with promising results indicated. A field review has been scheduled in March to look at the results.

The **BLM** will enter into a Memorandum of Understanding with the SCS for **a** Soil-Range Study in the Western United States in 1983. The specific details have not been formulated as of this date.

#### Research and Development (Soil-Plant Relationships)

- 1. Classification Seral Communities of Sagebrush Grass Habitat Types Idaho
- 2. Regional Forest Nutrition Oregon
- 3. Intermountain Forest Nutrition Idaho
- 4. Evaluation of Survival Potential, Douglas Fir Under Drought Stress Oregon
- 5. Plant Productivity, Phenology of Semi-Arid Rangelands Denver Service Center
- 6. Reynolds Creek Hydrology Idaho
- 7. Infiltration, Sedimentation, and Runoff Denver Service Center
- 8. Research on Cryptogamic Soil Crusts in Arid and Semi-Arid Rangelands Utah
- 9. **Saval** Ranch Hydrology Nevada
- 10. Rio **Puerco** Project New Mexico

#### Data Management and Analysis

The SCS supplies most of the soil information needs for project soil surveys in the Bureau. Computer assisted writing (CAW) is used extensively in cooperation with the SCS. The Bureau has no comparable system.

The Bureau's Denver Service Center has developed **an** extensive system for handling soils and vegetation information related to range management. Soil names, range sites, ecological condition class, stocking **guides**, and carrying capacity by **AUM's** per acre are among the kinds of information available. The computer can be accessed by user groups, and each **BLM** State has a terminal. This information can be made available to other users outside the Bureau.

#### Training

The Bureau will continue to look to the SCS for training of their soil scientists. The soil courses that the Bureau's soil scientist would be interested in are: Soil Correlation, Soil Laboratory Data Use, Soil Mechanics, Soil Institute, and Basic Soil Surveys.

The Bureau is developing a Beginning Soil Scientist Training Course to be given at our Phoenix Training Center. This course will be made available to other Agencies for their training needs.

#### Future

The objectives of the National Cooperative Soil Survey are consistent with the **BLM** objectives regarding soil surveys; that is, securing reliable, accurate. and creditable soils information for use and management of the public lands that the Bureau manages.

The soil survey is a priority item for information needs through 1989. A cooperative effort between the **BLM** and SCS is necessary to meet the Bureau's goals in the coming years.

#### Reports of Agencies Participating in the National Cooperative Soil Survey

## U.S. Department of the Interior Bureau of Reclamation Activities

#### Soil Science - Related Activities Within the Bureau of Reclamation

There are numerous activities within the Bureau of Reclamation which have the occasion to make use of the soil survey. However, the number of ac tivities which could, and do make use of the soil survey is much smaller. Those activities of primary importance falling into the category of high usage may be listed as:

a. Economic land classification for irrigation

b. Drainage and reclamation of salt-affected lands on existing irrigation projects

c. Engineering properties of soils, related to construction activities

d. Revegetation of disturbed lands

By far, the greatest users of the soil survey, in the group listed above, would be the soil scientists involved in the selection of lands for irrigation development. Substantial use is made of the surveys depending upon the level of detail at which the investigation is being conducted. If the classification is being conducted at the appraisal or reconnaissance level, a wealth of information can be gleaned from the use of soil surveys from a physical and chemical standpoint. This information can prove useful in the completion and interpretation of irrigation investigation studies.

#### Use of Soil Surveys in Land Classification Activities

Continued constraints, at the Federal level, still exist curtailing the resumption of new starts on irrigation projects. Whether studies are resumed under Federal, state, local or private funding and direction, the most expedient means should, and probably will be employed to advance the studies as rapidly as possible. In many instances this will involve lands with no previous history of agricultural development, while others may have been subject to various forms of crop production under rainfed conditions. Some of these lands may have had a soil survey while others will not. It is quite reasonable to assume that if this type of work is resumed under Federal authorization, in the very near future, inhouse manpower will be limited. This factor will accent, more than ever, the seeking of supplementary reliable data from various sources to reduce the time involved in the investigation process.

It might be well at this point to consider the Bureau of Reclamation's definition of land classification to avoid confusion between the terms "soil survey" and "land classification."

"Irrigation suitability land classification is the systematic appraisal of lands and their designation by categories or classes on the basis of similar physical and chemical characteristics and related economic conditions with respect to suitability for irrigation farming and irrigation service under a plan for water and land resource development. Irrigation fanning suitability connotes a reasonable expectancy of permanent, profitable production, climatically tempered, under irrigation. It is measured in terms of anticipated return to farm labor, management, and capital including onfarm land development costs. The survey is an economic and physical designation of land into categories. i.e., land classes defined in terms of family income and payment capacity."

This definition indicated much more than an inventory of the soils of an area in terms of their genesis and morphology. Correlation of soils, substrata characteristics, drainage factors, and economic parameters are critical to the accomplishment of land classification studies.

In further pursuance of the question of "new starts" in irrigation project development, whenever the time approaches, regardless of the sponsoring agent or agency, time will be of essence to economically get the project into operation. The most viable tools available will be sought to implement the operation in the shortest period of time. The soil survey would be one of these tools.

When we speak of the merits of utilizing soil survey data in accomplishment of land classification studies, it is not a matter of whether or not soil surveys have merit, for they unquestionably do; rather, it is a matter of the relative merit of the various approaches which may be taken in utilizing the data which they make available relative to an irrigation suitability land classification.

In many cases,

with the boundaries of soil survey mapping units. Ranges of characteristics within soil survey mapping units may well be great enough to encompass more than one land class (payment capacity range); substrata or drainage characteristics related to a particular soil survey mapping unit may differ sufficiently to result in substantially different levels of payment capacity; or topographic differences may vary to such an extent within one soil survey mapping unit that the cost of development for irrigation might merit separate units in terms of payment capacity. With these and other factors in mind, it is not possible to transfer soil survey delineations directly onto a land classification map, or vice-versa.

There are some quite definite relationships existing within the two systems. Although the soil profile is not sampled strictly on the basis of genetic horizons in the land suitability classification, a correlation exists between the physical and chemical characteristics of the soil regarding suitability of lands for specific purposes. The physical factors of texture, structure, color. and consistency, in most cases, have a direct relation to chemical content, especially if the chemical content is excessive and triggers an unfavorable climate for plant development. Therefore, if care is taken in these systematic delineations, as there should be, a fairly close relationship can be drawn in correlating results from soil profiles in close proximity, taken from the two systems.

Detailed irrigation suitability studies require a considerable amount of site-specific data relative to soil chemistry, substratum permeability and chemistry, soil water characteristics. etc. Since this type of data is not normally available from the typical second and third order soil surveys available to us, it is therefore necessary for us to gather it in order to complete our studies. Additionally, economic data relative to yield levels, crop adaptability, costs of production, land development costs, etc., are correlated with the physical and chemical data to complete the process of predicting payment capacity. This process is similar in many ways to parts of soil survey interpretive programs, and a study of it might prove useful in such programs. An exchange of such informational data might be suggested.

#### Ongoing Soil Survey Interpretive Activities

1

As previously mentioned, the Bureau of Reclamation has for some time made use of soil surveys in the conduct of land suitability classification studies, and continues to do so. This is particularly true of our appraisal level studies, but also holds true for some feasibility level studies.

Briefly, some of the studies currently in progress that may benefit by the use of quite recent soil surveys are:

a. Indian lands of the Central Arizona Project • Many of these lands did not receive an irrigation suitability land classification along with the project lands, consequently, current soil surveys could prove an asset in accomplishing this classification.

- b. Cendak Project, South Dakota Involves glacial till lands which may or may not have been included in the classification of lands in the, now defunct, Oahe Project. Drainage will be a key study in this classification. Soil surveys that can shed initial light on drainage problem areas would speed up the overall study process.
- c. Kennewick Extension Project, Washington Application is being made for loans under Public Law 130. The law requires a land classification prior to loan consideration.
- d. New Melones, California Involves 250,000 acres to be classified in order to be considered for water service under Public Law 130.
- e. Class 1 Equivalency Authorization of legislation involving this feature would involve a considerable workload. Although it would be in consideration of lands already under irrigation, there are numerous acres of class 1 land which has not gone through the development stage.

#### Needs and Opportunities in the Soil Survey - Land Classification Relationship

As can be seen from the foregoing, the needs relative to land classification are quite extensive, particularly in detailed studies; and it is unrealistic to propose that NCS surveys could meet them in total. However, we might suggest that such items as documented logging of at least some holes in addition to the generalized series description, additional specific laboratory data from located sites, field permeability testing of soils and substrata. etc., might be considered in potentially irrigated land areas.

It should also be pointed out that Bureau of Reclamation land classification data may be useful in many instances in meeting the needs of soil scientists engaged in NC soil surveys. A wealth of data useful in soil characterization has been gathered and is available in areas which have been studied by Reclamation. Interagency cooperation is a two-way street, and it seems obvious that both soil survey and land classification activities stand to benefit from it.

It appears clear that opportunities are plentiful for coaraunication and cooperation in the field of soil science in general, and between those engaged in soil survey and land classification activities in particular. Such cooperation, while it will probably never result in a complete understanding or agreement regarding all of the concepts or details of accomplishing different objectives, should at least lead to improved utilization of data collected and enhance mutual appreciation for our respective activities.

### WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

February B-12, 1982, San Diego, California

Kermit N. Larson USDA, Forest Service

There have been some major changes in our survey program in the past several years. One of these changes that would be of interest to you is our increased involvement in the National Cooperative Soil Survey (NCSS). Most, if not all of our recent survey starts are being included in the NCSS. This is due primarily to better communication and understanding of the objectives for soil survey of the respective agencies.

The trend in survey accomplishment in the Forest Service is down. In 1981 surveys were completed on 8,500,000 acres. This figure will be slightly lower in 1982. This compares to a high of 16 million acres in the late 70's. Due to budgetary constraints our annual survey accomplishment by 1983 will likely be below 6 million acres. The downward trend is a result of budget reductions, more detailed surveys, and soil scientist involvement in our Land Management Planning.

There are some special coordination problems in the West that we will have to work out in the near future. We have substantial acreages of completed soil surveys that have not been included in the NCSS. This is of particular concern in those States where the Soil Conservation Service has completed or will soon complete mapping on private lands. Some of these surveys could be included in the NCSS with a minimal amount of effort. Others may require major revisions. With the current budget outlook it will take a great deal of ingenuity on the part of both agencies to work this out.

The Forest Service is committed to the NCSS. This commitment was recently formalized by an amendment to the 1961 Memorandum of Understanding with the SCS relative to soil surveys. This amendment expresses strong support for the NCSS and documents several informal agreements between the two agencies over the past several years regarding soil survey. The specific purpose of the amendment are to:

- 1. Improve short and long-range planning and scheduling for soil surveys.
- 2 . Establish an objective of including all National Forest System lands in the NCSS and completion of a national soil survey once-over by the year 2000.
  - 3. Improve reporting of soil survey accomplishment and completion of SCS Soils Form 5.
  - 4. Clarification of procedures for soil surveys on public lands.

- 5. Establish procedures for correlation, interpretation, and reporting for order 3, 4, and 5 soil surveys.
- 6. Resolve future technical and administrative differences regarding soil survey.

Several of the committees at this conference have addressed some of these issues.

I am sure it will come as no surprise to you that the outlook is for reduced budgets in FY 1983. This will effect our survey outputs. As indicated earlier we will probably accomplish less than 6 million acres in 1983, and with reduced personnel we will have to take a hard look at many of our We may be forced to terminate some ongoing surveys and consolidate funding and personnel to other survey areas in order to maintain the efficiency of survey projects. We are placing strong emphasis on economics and the protection of soil productivity. This does offer some opportunities that we can take advantage of. We have a better data base than most of the resources do but we will have to give more emphasis to the economic implications of managing soils. I am hoping that the soil potential rating system of the SCS will allow us to deal with this issue. We have had several discussion recently with the National Soil Survey Staff and hope to conduct a pilot test of soil poten-tials for forestry in the Pacific Northwest.

## AGENCY REPORT SOIL CONSERVATION SERVICE

The Soil Conservation Service has undergone a number of Changes since our last conference. Mel Williams and Ellsworth Brown retired from the TSC, and Mon Yee of Arizona was added to our staff. Three state soil scientists - Oran Bailey, New Mexico; Theron Hutchings, Utah; and Jack Rasmussen, Washington - all retired, and Richard Fenwick, California, transferred to our National Headquarters In Washington, D.C. Gary Muckel, New Mexico, and Ron Hoppes, California, are attending their first conference as state soil scientists. The Utah and Washington positions are still vacant, but will hopefully be filled shortly.

George Hartman, our state soil scientist in Wyominq, recently suffered a heart attack, but I am happy to recort he is doing fine and should be back on the job in another month or two.

On the national level, fammiliar names like Bill Johnson, Jack McClelland. and Vic Link are gone. Dr. Ralph McCracken is our new Deputy Chief for Natural Resource Assessments; Dr. Klaus Flach, Associate Deputy; and Dr. Richard Arnold, Director of Soils.

Just briefly some statistics for the West "Region" SCS accomplishments during fiscal year 1981.

Initial field reviews were held in 12 survey areas and final field reviews in 14. The TSC processed 13 manuscripts, 9 of which were edited in-house. On the other hand, 29 surveys were published in fiscal year 81. This was possible through the increased production of our Cartographic Staff. Thanks to their good work, our backlog of surveys at GPO without maps is dwindling rapidly. According to the State APO's, SCS soil scientists mapped an estimated 20,000,000 acres during fiscal year 81.

During the past year or so, the Soils Staff at the West TSC tried to see how we could redirect our role to be more responsive to the needs of you people in the states and regions, as we all faced reduced budgets. We decided our best role would be to provide quidance and direct assistance, where that assistance would be most beneficial. We are no longer saying we must attend specific field reviews, but rather where do you need us the most. We will still attend some comprehensive field reviews - just possibly not all of them

Presented at Western Regional Technical Work Planning Conference for Soil Surveys (NCSS) at San Diego. California, February B-12. 1982, by Richard W Kover, Head, Soils Staff, West Technical Service Center, Soil Conservation Service, Portland, Dregon.

To meet these revised emphasis, we are Dutting the finishing touches on some quidelines for writing soil survey publications; we have drafted some proposed revisions of the National Soils Handbook which you are now field testing; we have attempted to streamline our processing of official series descriptions and reduce the number or copies printed; and we have spent a larger oercentage of our travel dollars on specific projects or oroblem areas than we have before. Some of our attempts at being innovative have not worked well, others worked good, with your help and suggestions; we should he able to work out any remaining hugs.

Another qual I would like is to field test all the applicable recommendations coming from our committees this week. We will then draft amendments to the National Soils Handbook or Soil Survey Manual to incorporate those committee recommendations that Drove feasible. I feel these procedures are necessary as neither NSH nor the Manual adequately addresses Order 3, 4 or 5 soil surveys using family or higher taxa as reference names.

All of our agencies are facing critical times in terms of budgets and personnel. If we are to maintain a viable National Cooperative Soil Survey in the West, it behooves all of us to work together to streamline our procedures without sacrificing either our quality or our technical standards. We must maintain our reputation for a top quality, technically sound product, or our soil surveys will lose their creditability.

#### MINUTES OF BUSINESS MEETING

The business meeting of the Western Regional Technical Work Planning Conference wascalled to order by Chairman Chuck Goudey, at 3:00 p.m. on February 11,1982, et the Catamaran Hotel, Se" Diego, California.

Bill Allardice presented the recommendations of the Laboratory Analyses Workshop (see report). Ed Naphan moved that the recommendations be accepted, seconded by Kermit Larson. motion carried.

Fred Peterson introduced Dr. Ralph Young, University of Nevada, Administrative Advisor to Western Regions, Coordinating Committee 30, Western Agricultural Experiment Stations.

The location and time of future conferences was discussed. Options discussed include: leave as is, rotate by states alphabetically (and by invitation), with steering committee made up of cooperators from host state, and rotate by warmer states. Fred Peterson suggested that the date be changed to the third or fourth week of February (less conflict

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Dieqo, California February R-12, 1982

# COMMITTEE 1

#### APPLICATION OF FIELD PROCEDURES FOR DIFFERENT ORDERS OF SOIL SURVEY

- I. Charge 1 Evaluate testing of field procedures described in 19R0 Conference Committee 1 report.
  - Test procedures for field sheet display of mapping intensity.
  - Test quidelines for delineation-identification procedure intensity.

#### **DISCUSSION**

- A. Committee 1 of 1980 Work Planning Conference presented amolified definitions for field procedures. These definitions included those for transects, traverses, observations, and air Dhoto interpretation. A recommendation proposed for testing included a field sheet display which would reflect mapping intensity. This display would be accomplished by writing a symbol in each delineation that reflects the major field procedure used for identifying the soil(s) of the delineation, thus documenting quality of map units. The following attached to the map unit symbol indicates:
  - A soil identification by transect
  - B soil identification by traverse
  - C soil identification by observation
  - D soil identification by air Dhoto interpretation,
- B. Committee 1, 1980, also recommended 'Guidelines for Delineation Identification Procedure Intensity." These quidelines consisted of the proportions of each delineation to be identified by the various procedures for each map unit of Order 2, 3 and 4 soil surveys.

# 1980 WESTERN CONFERENCE GUIDELINES FOR DELINEATION IDENTIFICATION PROCEDURE INTENSITY

	Soil Survey Order				
Mapping Procedure	Order 2	Order 3	Order 4		
<del></del>	% of delineations of each n				
(A) Transecting	15-30	10- 15	1-5		
(B) Traversing	50-65	25-50	10-15		
(C) Observation	5-15	25-50	40-60		
(D) Air Photo Interpretation	<5	10-20	20- 30		

II. Charge 2 - Revise proposed quidelines, procedures, and definitions as necessary and draft a revised "Kinds of Soil Surveys" document.

<u>DISCUSSION</u> - The work of the committee in relation to this charge was <u>nrlmarily</u> devoted to a review of the prior work of ad hoc committee 7, Kinds of Soil Survey, which led to the present document. Recommendations for changes and additions are made in this report.

# III. Work of the 1982 Committee 1, entitled "Application of Field Procedures for Different Orders of Soil Survey."

- A. Most of the work of the committee was done by correspondence which reported on testing of the proposed procedures recommended by the 1980 committee 1 and suggested revisions of the criteria defining "Kinds of Soil Surveys." These reactions to testing were reported:
  - 1. Field trials of displaying the symbols for field procedures on the field sheets indicated that it is no problem for field workers to do this.
  - 2. Some personnel found that writing detailed pedon descriptions for each point sampled on a transect demanded an unreasonable amount of time. The requirement for detailed pedon descriptions in transect sampling needs to be changed to a mere requirement for soil identifications of components.
  - 3. Responses to testing criteria for procedures for delineation identification proposed by the 1980 committee indicated that they demanded too many transects. It was generally indicated that the requirements imposed for transecting are too time consuming.
  - 4. A brief historical review of the development of the "Kinds of Soil Surveys" concepts was prepared and is aopended.

B.		and reports by field personnel, this
	committee is proposing the	following recommendations for testinq in
	the next two-year period.	

# IV. Recommendations

- 1. That the letter symbols A, B, C, or D, for the field procedure used to identify composition of a delineation, should be written in on the field sheets for each delineation. It should be written belownot as part of--the map unit Symbol in the delineation.
- 2. That the letter symbols for field procedures should not be used on the published map.

4.

a/

<u>b</u>/

c/

5.	That the above table "Guidelines for Procedures for Identifying the
	Composition of Delineations" is a reflection obolicy intent. In
	practice, proportions of Drecedures may shift during the survey of
	an actual area to reflect the ease or difficulty of soil identifi-
	cation and the potential use value of particular map units. After
	the survey Is completed, the actual Drooortions of procedures used
	to map each map unit should be reported in the published soil
	survey. The actual procedures ma.v include procedures not listed for
	the Order of soil survey if they can be shown to be reasonable;
	e.q., a few obvious delineations may be identified by air Dhoto
	interpretation in an Order 2 survey, even though

10. That Dick Cline be appointed Chairman of this continuing committee for the '84 Conference, and that he choose several committee members to immediately initiate action on testing.

# **Committee Members**

- S. Brownfield (SCS) \*
- J. Chuqq (ELM) \*
- R. Cline (FS) \*
- T. Cook (SCS)
- R. Dierking (SCS) \*
- R. Engel (SCS)
- R. Fenwick (SCS)
- M. Fosberq (UI) \*
- J. Harman (BLM) Chairman \*
- W. Harrison (SCS) \*
- L. Herman (FS) \*
- R. Herriman (SCS)
- G. Huntington (UCD) \*
- D. Jones (BIA) \*
- C. Landers (FS)
- R. Miles (SCS)
- E. Naphan (SCS) \*
- F. Peterson (UNR) \*
- V. Saladen (ELM) \*
- D. Smith (FS) \*
- G. Staid1 (SCS)
- T. Thorsen (SCS)

<sup>\*</sup> In attendance.

#### Committee 1

1982 Western Regional Technical Work Planning Conference of the National Cooperative Soil Survey

February 8-12, 1982, San Diego, CA

--Background Material --

#### A BRIEF HISTORICAL REVIEW OF THE "KINDS OF SOIL SURVEYS"

#### F. F. Peterson

The five Orders of soil surveys--proposed originally in 1972 to identify different soi 1 mapping intensities--have had surprisingly widespread use in the United States, considering that there has been no official publication of their definitions by the National Cooperative Soil Survey. Their widespread, informal use suggests that they are practical and serve a real need for identifying mapping intensities appropriate for different soil survey applications. Since first proposed, the criteria for the various Orders have been changed in response to critical review and field trial. There also have been questions about the meanings of some of the terms for field procedures, perhaps reflecting unavailability of definitions to field workers. This seems an appropriate time to review the development of this system, the concepts on which it is based, its operationally defined terms, and where the criteria for the Orders stand today--at least unofficially.

# The Original Proposal

During the 1960's demands for basic soils information for planning of extensive, unmapped areas in the western United States resulted in a rejuvination of reconnaissance soil surveys with mapping on small-scale air photos and soil identification by phases of soil series or families for soil association mapping units. Publication was commonly at 1:250,000 scale. In Alaska, an exploratory state soil map was being made on 1:500,000 field sheets using phases of subgroups to identify the components of soil associations. Soil survey experience during the preceding three or four decades had been largely with detailed mapping on large-scale air photos using very specific phases of soil series to identify the soils of mostly mono-component mapping units and some soil associations and complexes. Reconnaissance soil surveys were unfamiliar to most soil scientists and distrusted by some users. Field procedures were being developed. Guidelines for correlation and quality control were unavailable.

In 1972, W. M. Johnson (SCS) appointed a "Task Force for Guidelines for Reconnaissance Soil Surveys" to report to the 1973 National Cooperative Soil Survey Work Planning Conference on tentative "guidelines for field operations, nomenclature, legends, handbooks, interpretations, correlation, and publication of reconnaissance soil surveys." The task force members were: J. M. Williams (SCS,WRTC,Chm.), J. R. Coover (SCS-TX), R. C. Huff, (SCS-CA), V. C. Link (SCS-NH), E. A. Naphan (SCS-NV), O. C. Olson (FS-DC), F. F. Peterson (Nev. Agr. Exp. Sta.), and C. A. Steers (SCS-AL).

The task force concluded that reconnaissance soil surveys could not be described except in comparison with the familiar detailed soil surveys and occasional exploratory surveys—for which diagnostic criteria also were vague. Furthermore, there seemed to be need for and use of two levels of intensity of reconnaissance mapping between detailed and exploratory mapping. None of these kinds of soil surveys could be effectively differentiated by their intended uses, though the group attempted such definitions. Rather, a direct discription of how each kind of survey is made in the field, how the soils are identified, and how the locations of the soils are displayed on field sheets of different scales appeared to be the most workable way of distinguishing mapping intensity and soil data specificity. Four interrelated attributes wet-e used to distinguish the kinds of soil surveys with some degree of mutual exclusivity:

- 1. Kind of map unit.
- 2. Kind of taxonomic unit.
- 3. Field mapping procedures.
- 4. Mapping scale.

The 1951 <code>Soil</code> Survey <code>Manual</code> had already provided the most critical concept for this analysis. The authors of the <code>Manual</code> made an explicit distinction between how soils are identified and how their locations are shown on a map: The <code>taxonomic</code> unit is the device for identifying a soil body; this <code>more-or-less</code> complex name is formed from a class name from any categorical level of the <code>Soil Taxonomy</code> with or without an added phase distinction. Thus, soil identification at any level of categorical generality or specificity--plus non-taxonomic phase distinctions--can be had to vary the soil identification aspect of mapping intensity and data content. Since miscellaneous land types also can be taxonomic units, an additional variation on intensity of identification intensity is available.

The kind of map unit (or mapping unit, or cartogmphic unit) is the device by which map units comprised of delineations that either show exact or approximate location of individual soils are distinguished. The most significant distinction between kinds of map units is whether their delineations comprise a single kind of soil, hence show its exact location, or if they comprise two or more identified soil components per delineation, hence show only the approximate location of individual bodies of each component. Map units of the former type delineations are now called soil consociations. A secondary distinction was made by the Manual for map units of the latter, multi-component type delineations on the basis of component polypedon size: Those with component polypedons mappable at 1:20,000 scale are  $\hat{soil}$  associations, those unmappable at that scale are soil complexes. (The undifferentiated unit is yet another kind of map unit, but will not be discussed here.) Since the use of soil associations rather than soil consociations offers the possibility of wide degrees of cartographic generalization, depending on map scale, the choice of kind of map unit provides another variation on mapping intensity and geographic specificity.

The Soil Survey Manual also explained how mapping scale determines the maximum information that can be put on a soil map, the appropriate kind of map unit, and the appropriate categorical generality of taxonomic unit for various map scales. The task force added a deriviative criterion to map scale--

the minimum size delineation, i.e., the area represented by a 1/4x1/4-inch delineation at a given scale-for emphasis and ease of understanding the scale aspect of mapping detail. (The idea of the minumum size delineation was perhaps first used by A. C. Orvedal in Notes--Western States Workshop on Small-Scale Soil Maps, SCS, Portland, OR, 1967.)

Although the various terms for describing soil mapping procedures in the field are parts of the common and technical languages, the task force found that there was enough variation in usage and understanding that they wrote explicit, operational definitions for them. They also decided the traditional names for kinds of soil surveys--high intensity detailed, low intensity detailed, reconnaissance, and exploratory--had been so variously used and so vaguely defined that they were best abandoned. The terms 1st Order, 2nd *Order ... etc.*, were suggested to name the different intensities of surveys in analogy to civil engineering practice. Since then, the form *Order 1*, *Order 2 . . . seems* to have gained greater popularity.

The task force reported this proposal for "Kinds of Soil Surveys" to the 1973 National Conference. This 1973 version is shown in the attached Exhibit A along with the few terms defined in that report. For purposes of comparison Exhibit C shows an unofficial, "current" version of the classification along with a more complete list of definitions of terms. The 1973 report apparently stirred up considerable interest and no little critical reaction. Unfortunately, none of the discussion was reported in the Conference Proceedings.

#### Revision for the 1975 National Conference

A committee on "Kinds of Soil Surveys" was appointed in 1973 to study and revise the original proposal and report *to* the 1975 National Conference. The membership was the original taskforce with W. A. Wertz (FS-DC) replacing 0. C. Olson, and S. A. Pilgrim (SCS-NH) added to the membership. Although major revisions were made, the committee retained the basic logical scheme. The revised "Kinds of Soil Surveys" was accepted by the 1975 National Conference (Exhibit B).

#### Discussion of the 1975 Revisions

Order 1: Ultra-detailed soil surveys for experimental sites, urban design, and engineering purposes were recognized in the 1975 revision by reserving Order 1 for such high intensity surveys. To separate these from Order 2 surveys, a mapping scale of >1:12,000 was adopted as a break-point smaller than most ultra-detailed surveys would use, but larger than the common "standard detailed" soil surveys of the National Cooperative Soil Survey have used in the last few decades. For Order 1, emphasis was placed on soil consociation map units, though complexes were allowed. (Perhaps there are no soil complex mapping units at very large mapping scales?) An expanded field procedures section demanded examination of each delineation, but allowed either traverses or transects for soil identification. Observations were excluded for soil identifications, but were demanded for all soil boundary location, as compared with the allowable air photo interpretation for boundary location for the other Orders.

Whereas the 1973 version might have allowed some of the more intensely mapped "standard detailed" surveys into Order l--because of allowable mapping scales as small as 1:31,680--the1975 version excluded them by its >1:12,000 mapping scale limit.

Order 2: The 1973 version of Order 2 was designed to reflect the old "low intensity detailed" soil surveys. It limited map unit selection to "narrowly defined soil associations," yet demanded that each delineation be validated by traverse or transect. Its allowable mapping scales as large as 1:20,000 reached into scales used for "standard detailed" soil surveys, yet the commonly-used soil consociations and complexes of these latter surveys were excluded from Order 2. Thus, the 1973 version of Order 2 recognized a seldom-made type of survey while excluding a large number of "standard detailed" surveys.

The 1975 revision used Order 2 for the commonly-made, "standard detailed" soil surveys of the last **few** decades. It called for soil consociation, association, and complex map units in order of their common frequency of use. A minimum-size mapping scale of 1:31,680 excluded many "reconnaissance style" surveys. Exclusion of observations or air photo interpretation for soil component identification for any delineations blocked out all other reconnaissance surveys; it also failed to recognize that some observation-type soil identifications are indeed made for these Order 2 surveys.

The soil association map units allowed for the 1975-version Order 2 surveys should indeed be "narrowly defined"--as previously called for in the 1973 version--since relatively large-scale field sheets are called for, since most delineations are entered to identify soil components, and since phases of soil series are the only allowable taxonomic units. Compared with soil consociation and complex map units, soil associations can vary much more widely in the specificity or vagueness with which they show soil component location and in their heterogeneity, depending on whether large or small mapping scales are used and how the composition of the delineations is validated. In the 1975 revision, the widely ranging mapping intensities possible with soil associations is implied in the differentiation of Order 2. 3, and 4 soil surveys.

Order 3: In both the 1973 and 1975 versions, the soil associations of Order 3 were allowed more generality, as compared with Order 2 soil associations, by allowing smaller mapping scales and by the use of observations to identify the components of some of the delineations. Both versions allowed either phases of soil series or families as taxonomic units. (Perhaps the use of series should have been limited to surveys using relatively large mapping scales and frequent soil examinations to protect the implied greater data validity of a soil series-level identification.)

The 1975 version's allowance of mapping scales as large as 1:24,000 may have been a mistake for Order 3, since it results in increased numbers of delineations and smaller delineations, hence slower and more intense mapping approaching Order 2 mapping. The implied allowance of mapping scales as small as 13250,000 certainly was a mistake as it is not congruent with the other criteria for mapping intensity. The small scale was perhaps intended for publication scale; the mistake then would be to not separate the mapping from publication scale criteria.

Both soil consociations and complexes were allowed as map units in the 1975 version of Order 3 because large polypedons and large areas of complexes of small polypedons do occur in the western United States and can be readily mapped at Order 3 intensity.

Order 4: In the 1975 version, Order 4 surveys were distinguished from Order 3 surveys by less intensive field procedures and smaller mapping scales. Considerable reliance was placed on observations and air photo interpretation to identify the components of soil associations. Transects are used only to establish map unit composition and traverses are the major hard-validation procedure. Boundaries are plotted by air photo interpretation with observations only as they are attendant to other procedures.

Some consociations of soils occurring as very large polypedons are expected to be mapped in Order 4 surveys, as defined in 1975. Soil complexes probably would not be recognized at the low Order 4 mapping intensity, but this classification was not intended to be mechanically restrictive, and complexes might well be recognized where they form large and distinctive landscape elements.

As in the 1973 version, phases of soil families and subgroups are considered appropriate taxonomic units for Order 4 soil surveys. But phases of great groups were dropped in the 1975 revision, perhaps because most conceivable Order 4 surveys probably would be for purposes requiring more taxonomic information than is provided by great group identifications.

In the 1975 version, appropriate mapping scales were shifted toward larger scales for Order 4, than in the 1973 version, yet not far enough. Even the 1:100,000 scale, let alone the 1:300,000 scale, would not provide enough information for most conceivable uses of Order 4 surveys.

Order 5: This Order was still conceived as "exploratory soil surveys" in 1975 and remains so. Revision in 1975 allowed the use of phases of subgroups for taxonomic units and mapping scales as large as 1:250,000.

Revisions Recommended by the 1980 Western Regional Conference

During the latter 1970's, many Order 3 and 4 soil surveys were initiated and completed in the western United States. Traditionalist demands for the familiar soil Series-level identification of soils and mapping scales as large as 1:24,000--rather than identifications as analogous phases of families and mapping scales such as 1:60,000--pushed ostensible Order 3 surveys toward Order 2 mapping intensities and progress rates. On the other hand, some workers wondered if certain Order 4 surveys of difficult terrain might not qualify for Order 3--perhaps for image purposes. In both sorts of situations there were repeated questions about appropriate field procedures and quality control, perhaps because the definitions of the procedures were terse to a fault, if indeed available. In response to these valuable field tests of Order 3 and 4 mapping procedures, a committee on "Identifying Order 3 and 4 Soil Surveys" was formed for the 1980 Western Regional Technical Work Planning Conference for Soil Survey.

The committee's most significant recommendations were new guidelines for field mapping scales, proportions of delineations to be identified by various procedures, and field testing. The committee identified and emphasized the fact that field mapping scale is a--or probably the--most effective procedural

control for mapping intensity. They recommended holding Order 2 surveys to somewhat larger mapping scales, i.e., to 1:30,000 rather than the 1:31,680 scale of the 1975 revision (see Table 1 for comparisons). For Order 3, the largest mapping scale recommended was 1:30,000 and the smallest scale was 1:80,000. In practice, application of these new limits would encourage using a considerably smaller mapping scale than the common 1:24,000 scale of Order 2 surveys, and hence force more generalized designs of soil association map units than used for Order 2 surveys. For Order 4 surveys, mapping scales no larger than 1:60,000 or smaller than 1:125,000 were recommended. The 1975 revision had listed 1:100,000 to 1:300,000 as appropriate Order 4 scales, so the new recommendation recognized that the Order 4 surveys are intended to have enough data content and geographic specificity to be useful some management purposes in addition to very general planning.

TABLE 1

MAP SCALES OF THE 1975 AND 1980 VERSIONS OF "KINDS OF SOIL SURVEYS"

Orders	1975 Appropriate Field Mapping and Publication Scales	1980 Appropriat Field Mapping Scales
Order 1	>1:12,000	>1:10,000
Order 2	1: 12,000 to	1:10,000 to
	1:31,680	1:30,000
Order 3	1:24,000 to	1:30,000 to
	1:250,000	1:80,000
Order 4	1:100,00 to	1:60,000 to
	1:300,000	1: 125,000
Order S	1:250,000 to	1:125,000 to
	1:1,000,000	1:1,000,000

There is some sort of a limit to the degree of cartographic and categorical generality that a soil survey can have and yet provide enough data for purposes that warrant a progressive survey, as compared with an exploratory survey. The 1980 limit of 1:125,000 or larger mapping scale for Order 4 surveys may be such a practical breakpoint. With smaller mapping scales, procedures are apt to shift to exploratory procedures involving very widely-spaced observations and much synthesis from environmental features. However, Order 5 surveys were not discussed by the 1980 committee, nor was a "cap" on Order 4 surveys treated much.

Before recommending quantitative proportions of field procedures for the Orders, the 1980 committee suggested amplifications of the definitions of the operations by which the components of delineations are identified, i.e., of the *transect*, *traverse*, *observation*, and air *photo interpretation* procedures. These amplifications were intended to emphasize decreasing mapping intensity, decreased information collected, and decreased confidence of taxonomic identity and geographic location in the order that the field procedures are listed.

Next, the committee tentatively suggested the proportions of the delineations of a mapping unit the should have their soil components identified by the different-intensity field procedures, or mapping operations listed above (Table 2). For quality control, the committee also recommended that a record of how soil identifications were made be kept for each delineation by putting a suitable symbol *in* each delineation on the field sheets, e.g., the "A", "B", "C", and "D" of Table 2. And, when transecting is used to establish composition of soil associations, the location of the transect should be noted on the field sheet and detailed records kept on appropriate forms. The se last recommendations were suggested for field testing, and there have been effective tests made by field mapping parties in the interim.

TABLE 2

1980 WESTERN CONFERENCE GUIDLINES FOR DELINEATION—
IDENTIFICATION PROCEDURE INTENSITY

	Soil Survey Order				
Mapping Procedure	Order 2	Order 3	Order 4		
	% of	delineations of	each map unit		
(A) Transecting	15-30	10-15	1-5		
(B) Traversing	SO-65	25-50	10-15		
(C) Observation	5-15	25-50	40-60		
(D) Air Photo Interpretation	<b>&lt;</b> \$	10-20	20-30		

These 1980 recommendations are substantial revisions of the criteria for the Orders. They result from several years experience with Order 3 and 4 surveys that were not previously available. They also clarify the relative characters of the Order 2 and 5 soil surveys. Although the committee did not explicitly call for separating the field mapping scales and publication scales as criteria, or for inclusion of the guidelines of Table 2 in the field procedure criteria, such are implied.

# Unofficial 1981 Version of "Kinds of Soil Surveys"

The "Kinds of Soil Surveys" is a very useful reference concept for discussing soil surveys. When I wrote Landforms of the Basin and Range Province-Defined for Soil Survey Nev.

lst Consociations, or complexes 1/2 acre to 10 acres 2<u>nd</u> Narrowly 5 acres defined to 40 acres associations 40 acres 3<u>rd</u> Consociations Broad phases of & associations to soil series 640 acres and phases or soil tamilies

4<u>ch</u>

5<u>th</u>

#### DEFINITIONS OF TERNS GIVEN IN THE 1973 VERSION

- (1) Sooid ps: soil maps show the geographic distribution of different kinds of soil and the mapping units are defined by their component soils; the soils are classified according to the criteria of the Soil Taxonomy.
- (2) Soil survey: a soil survey is a soil map and accompanying report which are based primarily on field **methods1**/ for identification of kinds of soils and soil boundaries.
- (3) <u>Generalized</u> soil man: a generalized soil map (also "General Soil Hap") is one made by abstraction from a more detailed soil survey map.
- (4) Schematic soil map: a schematic soil map is one made with little or no fieldvestigations. Soils are identified by interpretation from aerial photos, geologic and geomorphic features, vegetation, climate, or other information about genetic factors.

 $\frac{1}{Remote}$  sensing techniques are becoming increasingly important.

# Terms for Describing Soil Survey Operations

The task force found it needed objective, or "operational" definitions of several terms that were used to describe the procedures of soil surveying; individual understandings of these terms are variable enough that during discussion unwitting confusion occurred unless we had explicit definitions at hand. The following partial list of terms repeats most  $\circ$ f the traditional understandings, but is intended to stress chose operations-those things we &--which are characteristic of various soil survey procedures.

- 1. <u>Transect</u>: (1) The field procedure of crossing delineations or landscape units along selected lines to determine the pattern of pedons vith respect to landforms, geologic formations or other observable features. Thus, visible, or simply determinable features are related to soils, and soil occurrence can be predicted locally.
- Also, (2) a statistical sampling procedure of crossing delineations on selected or random lines, and identifying pedons at predetermined points for subsequent formal or informal statistical evaluation to establish the composition and variability of a delineation or mapping unit.
- 2. <u>Traverse</u>: Validation of the predicted boundaries or composition of a delineation by entering it, or crossing it, and identifying pedons at selected or random positions.

- 3. Observation: Visual checking of landscape features, exposed geological formations, or chance exposures of pedons from within or without a delineation to project boundaries and composition from previously determined relations; pedons are not examined; air photos may be used as guides, but this is a field operation and not merely photo interpretation. This is a less intensive operation than traversing.
- 4. Air Photo <u>Interpretation</u>: Plotting boundaries and soil composition of delineations (or other landscape features) from photo features which have been previously related to soil occurrence. This is basically an office procedure.
- 5. <u>Sampling:</u> (1) taking physical samples from pedons for later laboratory or field analyses.
- Also, (2) identifying pedons in a **systematic** or random fashion for subsequent statistical analysis.
- 6. <u>Identification:</u> (1) the systematic determination of the properties and features of a pedon (or pedons of a polypedon). including laboratory analyses where needed, and subsequent keying through an established soil classification system to find the **class(es)** within which the pedon (or polypedon) fits, or the absence of such a **class(es)**, or determination of status as a taxadjunct. This operation concerns naming of individual things.
- Also, (2) the immediate **perception** on viewing or brief examination (i.e., the gestalt) of the class affinity (name) of a pedon or polypedon.
- 7. <u>Correlation:</u> The field and office procedures of review by which the accuracy and appropriateness of taxonomic unit identification, mapping unit design, mapping legends, field notes, pedon descriptions, and other soil survey operation are maintained.

Terms for Describing Kinds of Mapping Units

The recognition of different types, or "orders" of soil surveys, which is presented later, demands analysis of the kinds of mapping units used in each. We found we had no term explicitly identifying a mapping unit of only one component, regardless of the level of taxonomic abstraction at which that component is identified. Definitions for "delineations", "consociations", "associations", and "complexes" are given here to provide the complete context within which each term is used; the term "delineation" is included to emphasize that mapping units per se are groups, or classes, of similar soil-landscape areas (i.e., delineations), and as such are as wholly open to levels of abstraction as are the soil taxonomic units.

1. <u>Delineation:</u> A selected and differentiated portion of a landscape circumscribed by a boundary on a map and that contains an unique composition and pattern of soils; the boundary of a delineation can be placed at the boundary of a polypedon identified by use of soil series-level **differentia**, or **at** the boundary of a polypedon **or** contiguous polypedons identified by use of soil family (or higher)-level differentia. or by application of phase-level differentia.

- 2. Consociation: A mapping unit in which only one identified soil component (plus allowable inclusions) occurs in each delineation. The term consociation has not been used in soil science but is needed to identify mapping units of only one identified component. It is manufactured from the element con ("opposed to" or "negative") and the element sociate (from association, "to join", "to share", "companion") and means things which are single, not a companion of other things. The term reportedly has been used by plant ecolologists to identify stands of single species as opposed to associations of several plant species.
- 3. Associations: Definition as given in Soil Survey Memorandum 66.
- 4. **Complexes:** Definition as given in Soil Survey Memorandum 66.

#### CRITERIA FOR IDENTIFYING KINDS OF SOIL SURVEYS 1/

Xinds of Soil Survey	Kinds of 2/ Map Units	Kinds of Components	Field Procedures	Appropriate Scales for field Mapping and Published Maps	Minimum 3/ Size Delineation
ist Order	Mainly consocia- tions and some complexes	Phases of soli series	The soils in each delineation are identified by transacting and traversing. Soil boundaries are observed throughout their length. Air photo used to aid boundary delineation.	<1:12.090 W	<1.5 ācrēs
2 <u>nd Order</u>	Consociations, associations and complexes	Phases of soil series	The soils in each delineation are identified by transecting and traversing. Soil boundarties are plotted by observation and interpretation of remotely sensed data. Boundaries are verified at closely spaced intervals.	1:12,000 to 1:31,680	l.5 acres to LO acres
3rd Order	Associations and some consociations and complexes	Phases of soil series and soil families	The soils in each delineation are identified by transecting, traversing and some observations. Boundaries are plotted by observation and interpretation by remotely sensed data an vertified with some observations	1:24,000 to 1:250,000	6 acres to 640 acres
4 <u>ch Order</u>	Asociations with some con- sociations	Phases of soil families and aubgroups	The soils of delineations rep- resentative of each map unit are identified and their par- terns and composition deter- mined by transacting. Subse- quent delineations are mapped by some traversing, by some observation, and by interpretat of remotely seneed data verifie by occasional observations. Bo daries are plotted by air photo interpretations.	d un-	100 acres to 1,000 acres
Sch Order	Associations	Pheses of subgroups, great groups, suborders ' and orders	The soils, their patterns, and their compositions for each map unit are identified through map selected areas (15 to 25 sq. mi with lst or 2nd order surveys, elternatively, by transecting. Subsequently, mapping is by wid spaced observations, or by ince tation of remotely sensed data occasional verification by obsection or traversing.	ping les) or ely rpre- with	640 acres to 10,000 acres

<sup>1/</sup> Soil surveys of ail Orders require maintenance of a soil handbook (legend, mapping unit descriptions, taxonomic unit descriptions, field notes, interpretacions) and review by correlation procedures of the National Cooperative Soil Survey. Work plans for many survey areas list more than I order; the part to which each is applicable is delineated on a small scale map of the survey area.

<sup>2/</sup> Undifferentiated groups may be used in any order with possible exception of ist Order.

If This is about the minimum size delineation for reseable soil maps (i.e., 1/4 x 1/4 area)--see Table 3. In practice the minimum size delineations are generally larger than the minimum shown.

<sup>4</sup> ist Order soil surveys are made for purposes that require appraisal of the soil resources of areas as small so experimental plots and building sites. Suppling scale could conceivably be as large as 1:1.

#### DEFINITIONS OF TERMS GIVEN IN THE 1975 VERSION

# SOIL MAPS AND SOIL SURVEYS

To provide a context for our concepts of "kinds of soil surveys" we followed these capsule definitions of maps sad surveys:

<u>Soil survey</u>: A soil survey is a field investigation resulting in a soil map and accompanying report.

Soil Maps: Soil maps show the geographic distribution of different kinds of soil sad their map units are named and defined by their cwpoaeat soils. Soil maps are made for many different purposes. Some objectives require refined distinctions among kinds of soil that occupy small homogeneous soil areas. Other uses require broad perspective of the soils of large distinctive areas. Three kinds of soil maps are distinguished on the basis of the procedures that produced them.

Soil Survey Map:	Generated	by	field	investigations with	varying
	_				

- 2. <u>Consociation</u>: A napping unit in which only **one** identified **taxon** (plus **allowable** inclusions) occurs in each delineation.
- 3. <u>Soil Association</u>: An association is a geographic mixture of areas of two or more distinctive **kinds** of soil. or of a soil and a kind of **miscellaneous** area. Unlike complexes, however, the areas of the principal components of soil **associations can** be delineated separately by detailed **soil survey** methods at map **scales** of about **1:20,000**. Associations **are used** as mapping units either where map scales are too small to permit delineation of the components separately **or where** the Intensity of soil survey methods does not permit identifying the boundaries that separate the components.

Associations are **used** mainly for general soil maps. They are used in some **otherwise** detailed surveys as mapping units for **some** areas for which the cost of delineating their components separately are greater **than** the anticipated benefits.

Soil associations may be identified in terms of soil series or taxa of higher categories, depending on the range of soil properties included. On general soil maps of relatively large scale, soil series names ars commonly used. The "Cohoe-Kenai association" is an example. The "Hollis-rock outcrop association" is an association of Hollis soils and a kind of miscellaneous area. On maps of small scale, delineated areas must

2nd Revision

# APPENDIX I

# KINDS OF SOIL SURVEYS AND SOIL SURVEY TERMS

TABLE 1
CRITERIA FOR IDENTIFYING KINDS OF SOIL SURVEYS'

Kinds of Soil Survey	Kinds of Map Units	Kinds of Taxonomic Units	Field Pracedures:	Appropriate Scales for Field Mepping and Published Mags	Minimum Site Delineation'
Order 1	Mainly soil consociations and some	Phases of soil series	The soils in each delineation are identified by transecting or traversing. Soil boundaries are observed used to aid boundary delineation.	>1.10,000*	< ).0 acre
Order ?	Soil consociations, associations, and complexes	Phases of soil series	The toils in each delineation are identified by transacting or traversing. Soil boundaries are plotted by observation and air photo interpretation and verified at closely spaced intervals.	1. t9.090 to 1.39.090	1.0 acre to 9 0 acres
Order 3	Soil associations and tome toil consociations and completes	Phases of soil sence and soil families	The soils in each delineation are identified by stansecting, traversing and some observations. Boundaries are plotted by observation and air photo interpretation and verified by some observation.	1:30,000 to 1:80,000	9.0 acres 64 acres
Order 4	Soil associations with some soil consociations	Phases of soil families and soil subgroups	The soils of delineations representative of each map unit are identified and their patterns and comparition determined by transecting. Subsequent delineations are mapped by some traversing, by some observation, and by air photo interpretation verified by occasional observations. Boundaries are plotted by air photo interpretations.	1:60,000 to 1:125,000	36 acres to 156 acres
Order 5	Soil associations	Phases of 10th 10th 10th 10th 10th 10th 10th 10th	The soils, their patterns, and their com- positions for each map unit are identi- fied through mapping selected areas (15) to 25 sq miles) with Order 1 or 2 sur- veys, or alternatively, by transecting. Subsequently, mapping is by widely spaced observations, or by air photo interpretation with occasional verification by observation or traversing.	1.325,060 to 1 t.809,000 (publication scales)	156 acres co 10,000 acres

Soil surveys of all Orders require maintenance of a soil handbook (legend, map unit descriptions, Caronomic unit descriptions, field notes.

Field procedure terms are used with meanings defined in Table 2 of this Appendix.

<sup>&</sup>quot;This minimum size delimpation is the land area represented by the about minimum size area on a map theer—at a given scale—within which a symbol can be printed to 4,4 kly-inch aquare or roughly circular delineation of 1. This quare incharces. Such small delineations can be shown legibly only when isolated within much larger delineations. An exact map of infermingled polypedons which would show as minimum size delineations would be illegible, either the scale would have to be considerably enlarged, or soil complexes or associations shown instead of soil consociations. Smaller than minimum size delineations can be used with acrowed in symbols, or spot is moult can be used to locate isolated, very small, highly significant land areas. "Order 1 soil surveys are made for purposes that require appraisal of the soil resultees of areas as small as experimental prots and building sites. Mapping wait could conceivably be as rarge as 1.1.

Air photo interpresonanta meant to include interpretation of any remotely sensed data available

#### TABLE 2

# DEFINITIONS OF TERMS USED TO DEFINE KINDS OF SOIL SURVEYS

- 5 Soil Survey: A soil survey is a soil map and accompanying report which is based on field investigations and usually supported by air photo interpretation.
- 2 Soil Maps: Soil maps show the geographic distribution of different kinds of soil and their map units are named and defined by their component soils. Soil maps are made for many different purposes.

Some objectives require refined distinctions among kinds of soil that occupy small homogeneous soil areas. Other uses require broad perspective of the soils of large distinctive areas. Three kinds of soil maps are distinguished on the basis of the procedures that produced them.

- 24. Soil Survey Map: Generated by field investigations with varying amounts of supporting information from photo interpretations
- 18 Generalized Soil Mag: Produced by combining contiguous delineated areas of precising soil maps that were made by field procedures to make targer delineations on a new map.
- 2C Schematic Soil Map: This kind of soil map is made by predicting kinds of soils and the areas they occupy from existing information without the benefit of preexisting soil survey maps or more than very limited field investigations.
- 3 Teamsect: (1) The field procedure of crossing delineations or landscape units along selected lines to determine the pattern of polypedons with respect to landforms, geologic formations or other observable features. Thus, visible or simply determinable features are related to soils, and soil occurrence can be predicted locally from these features.

Transects require explicit documentation including (1) a symbol locating the transect on and keying the documentation to a field sheet (e.g., "T-73"), (b) a planimetric sketch of the location of the transect within the delineation showing variations from a straight line, etc., (c) a cross-section diagram of the component soils, associated vegetation, landforms, geology, etc., (d) a pedon description of each component soils (e) a statement of the landscape factor related to each soil boundary; and (f) the percentage soil component composition based on the entire transect length. This document validates the composition of soil map units (particularly soil associations) and explicitly shows the mapping clues by which additional delineations may be identified. Air photo interpretation is used during transecting

(2) Identifying pedons at regularly spaced intervals (i.e., gridding).

Also, (3) a procedure of crossing delineations on selected or random lines, and identifying pedons at predetermined points for subsequent formal or informal statistical evaluation to establish the composition and variability of a delineation or mapping unit.

4 Teaverse: Validation of the predicted boundaries or composition of a defineation by entering it or crossing it and identifying pedons at selected or random positions.

A traverse requires that the significant horizons of each soil component in a delineation be examined physically by shower or auger. For Order 3 and 4 surveys, the location of the examination should be shown by a symbol within the delineation drawn on the field sheet, and keyed to field notes if notes are made. If all component soils of a delineation are not examined or the examination site is not located by a symbol the mapping operation shall be considered an "observation." Air photo interpretation is used during traversing.

5 Observation: Visual checking of landscape features, exposed geological formations, or chance exposures of pedons from within or without a delineation to project boundaries and composition from previously determined relations, air photos may be used as guides. This is a less intensive operation than traversing.

Identification of component soils by observation uses air photo interpretation, but requires an on-ground view close enough that individual shrubs, stones, and chance exposures of soil horizons can be seen clearly, i.e., closer than a few hundred yards. Air photo interpretation, or views from aircraft are not Tobservations. "Examples of observations: seeing fragments of a perfocultie, or a ditchbank exposure of an argillic horizon from a pickup window. A two-foot high scarp that is known to separate soils, but is not visible on stereo air photos. Cobbles of limestone on a hillside that are a clue for a particular soil. Indicator plants or changes in shrub height or density that is related to soil change. The sensation of soften or firmer soil when walking across an area, and noting it is related to soil color and apparent texture. Salt efflorescences

 Ait Photo Interpretation: Plotting boundaries and estimating composition of delineations based on air photo features that have been related to soils and landscape features. As the term is used here, air photo interpretation includes applicable remote sensing.

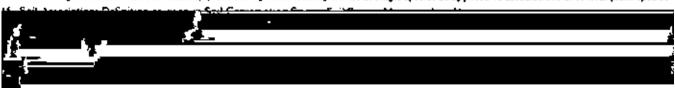
Airphoto interpretation is a strictly intellectual, second hand conclusion based on previous correlation of landscape features and photo patterns to soils. In compassion, an "observation" is a concrete, novel experience where many more landscape features are apparent and their significance can be tested, than is possible with air photos, particularly at scales appropriate for Order 3 and 4 mapping.

- 5- Sampling: Taking physical samples from pedons or selected horizons for later laboratory or field analyses. The soil material is called a soil specimen.
- 8 Identification: (1) The systematic determination of the properties and features of a pedon for pedons of a polypedont, including laboratory analyses where needed, and subsequent keying through an established soil classification system to find the classifes) within which the pedon for polypedon) fits or in the absence of such a classifes), determination of status as a soil variant or soil taxadjunct. This operation concerns naming of individual things from an existing classification.

Also, (2) the immediate perception (i.e., the gestalt) on viewing or brief examination of the class name of a pedon or polypedon

- 9 Classification: The conceptual grouping and separation of similar and dissimilar polypedons subsequent to examination of a large enough number of these individuals to provide a more-or-less valid sample of a population of real soils in some geographic area. Although concepts from existing classifications unavoidably guide examination and grouping, stress is placed on the properties of a real population of individuals, whereav during identification, stress is on relating an individual to the classes of an existing classification. During soil mapping, classification-type thinking is used to set up relatively few new soil series, or families, or phases, whereas identification-type thinking is used routinely for naming numerous soil areas.
- 10. Correlation: The field and office procedures of review by which the accuracy and appropriateness of taxonomic unit identification, map unit design, mapping legends, field notes, pedon descriptions, and other soil survey operations are maintained.
- 91 Defineation: A selected and differentiated portion of a land-scape that contains a unique composition and partiets of soils and is identified by a boundary on a map. The boundary of a defineation can be placed at the boundary of a polypedon identified by use of soil series-level differential or at the boundary of a polypedon or contiguous polypedons identified by use of soil family (or highest-level differential or at the boundary of a landscape unit containing a describable pattern of soils or land types described at any categorical level.
- 12 Map Unit: A map unit is a conceptual group of many delineations—but occasionally only one delineation—which represent very immiar landscape units comprised of the same kind of soil or miscellaneous land type, or two or more kinds of soils or miscellaneous land types. The map unit definition, or description, names and identifies the soils or land types of the delineations by taxonomic units, Inclusions also should be described if they have been identified. For soil associations and complexes, proportion and landscape pattern of components should be described.

- 13 Taxonomic Unit: A taxonomic unit is the complete identification of a soil or misceilaneous land type component of a map unit, hence of delineations. Commonly a soil taxonomic unit consists of a class name from any categorical level of the Soil Taxonomy plus phase distinctions such as slope class.
- 14 Soil Consociation: A map unit in which only one identified soil component (plus allowable inclusions) occurs in each delineation. The term consociation is needed to identify map units of only one identified component. It is manufactured from the element con Copposed to or negative Tand the element sociate (from association, To join, Trombare, Theorem panion Tand means things which are single, not a companion of other things. The term has been used by plant ecologists to identify stands of single species as opposed to associations of several plant species.



each delineation, the boundaries of which connot be mapped at 1:20,000 scale, or the boundaries of the component soils cannot be accurately plotted without closely spaced gridding since the soil boundaries cannot be accurately

Note: Missing definitions:

- (1) A complete definition for "soil associations".
- (2) A complete definition for "soil complexes".
- (3) A definition for "undifferentiated map units".
- (4) A definition for "inclusions".

APPENDIX II
GUIDE TO MAP SCALES AND MINIMUM-SIZE DELINEATIONS

Order <b>of</b> Soil Surrey Map	Map Scale	Inches per Mile	Minimu <b>Deline</b>	
	1:500	126.7	acres 0.0025	hectares 0.00 1
	1:2,000	31.7	0.040	0.016
ORDER I	1:5,000	12.7	0.25	0.10
	1:7,920	8.0	0.62	0.25
	1:10,000	6.34	1.00	0.41
	1:15,840	4.00	2.5	0.1
ORDER 2	1:20,000	3.17	4.0	1.6
	<b>1:24,000</b> (7.5')	2.64	5 . 7	2.3
	1:30,000 .	2.11	9.0	3.6
	1:31,680	2.00	10.0	4.1
ORDER 3	1:60,000	1.05	36	14.5
	1:62,500 (15′)	1.01	39	15.8
ORDER 4	1:63,360	1.00	40	16.2
	1:80,000	0.79	64	25.8
	1:100,000	0.63	100	40
	1:125,000	0.51	156	63
	1:250,000	0.25	623	252
ORDER 5	1:500,000	0.127	2.500	000,1
	1:750,000	0.084	5.600	2.270
	1:1,000,000	0.063	10.000	4.000
Very	1:7,500,000	0.0084	560.000	227.000
Generalized	1:15,000,000	0.0042	2,240,000	907.000
Soil Maps	000,000,88:1	0.0007	77,000,000	31,200.000

The minimum size delimentor is taken as a 4-x4-inch square or circular area of 1-16 sq. in, area. Carcographically, this is about the smallest area in which a symbol can be printed readily. Smaller areas can be delineated and the symbol lined in from outside, but such very small delineations drastically reduce map legibility. Minimum size delineations must occur as isolated areas within much larger delineations for good map legibility. A map composed of largely minimum size delineations is illegible and impractical. Such a map can be reprinted at larger scale, or redraited with adjacent delineations combined into larger delineations tile... more generalized map units such as soil complexes and soil associations for improved legibility.

#### Committee I

1952 Western Rugional Tachnical Work Planning Conference of the National Cooperative Soil Survey February 3-12, 1982, San Diego CA

#### Sampasine 1982 Vereion for Discussion

# PART I CRITERIA FOR IDENTIFYING XINDS OF SOIL SURVEYS:

Kinds of Soil Surveys	finds of Map Units	Kinds of Taxonomic Units	Field Procedures <sup>5</sup>	Appropriate Field Mapping Scales	Minimum Size Gelineation <sup>S</sup>
Owder :	Mainly soil consociations and 1 few soil complexes	Phases of soil series	The soils in each fellmestion are identified by traversing or transecting. Soil boundaries are observed throughout their length. Air shoto interpretation used to aid boundary delimention.	*1:40,000 <sup>2</sup>	<1.0 acre
Order (	Soul consociations, associations, and some soil complexes	Phases of soil series	The soils in each defineation are identified by traversing, or observation, or transecting. Soil boundaries are plotted by observation and air photo interpretation and verified or closely spaced intervals.	1:10,000 co 1:125,000	1.0 acre to 6.2 acres
Jrder 3	Soil associations, some loid consociations, and a few soil complexes	Phases of soil series, or soil families	The soits in each delineation are identified by traversing, or observation, or air photo interpretation, or transecting. Soundaries are plotted by observation and by air photo interpretation varified by some observations.	1:25,000 to 1:60,000	6.2 acres to 36 acres
Order ↓	Soil 1530013ELONS 100 1 fem 501 CONSOCIATIONS	Phases of soir families, or soil subgroups	The soils of delineations representative of each map unit are identified and their proportions and patterns determined by transecting. Subsequent delineations are mapped by observation, or air photo interpretation verified by occasional observations, or by, traversing. Soundaries are photied by air photo interpretation.	1:60.000 cs 1:200.000	36 30748 to 399 30749
Orgen 5	Soil associations	Phases of soil subgroups, or soil great groups, or soil suborders, or soil orders	The socia, their patterns, and their proportions are identified for each map unit either by mapping selected areas (15 to 25 sq. maies) by Order 2 survey, or elternatively, by transecting abbsequent mapping is by air photo interpretation occasionally vectified by observations, or by traversing. Soundaries are plotted by air photo interpretation.	1:200,000 to 1:500,000	399 Acres co 1,300 Acres

Soil surveys of all Orders require maintenance of a soil handbook (tagend, map unit descriptions, taxonomic unit descriptions. field note, interpretations) and review by correlation procedures of the National Cooperative Soil Survey. Note plans for a soil survey area may list more than one Order of mapping: the part to which each Order is applicable shall be definedted on a small-scale index map of the area.

Plant identifications for a few of the map units of Order 7. 3. 8 soil surveys may be used at higher categorical layers than the common taxonomic unit used for the survey when great soil complexity or low use potential make more specific soil identifications imagoropriate.

Esteld procedure terms are defined in Part II of this classification. Publication scale to be chosen to fit the uses.

<sup>15</sup>ce lefinition of thei⊤at size delineation. Part III: Guide to Map Scales and Minimum Site Delineations.

<sup>\*</sup>Order 1 soil survers may be made for purposes that require appraisal of soil areas as small as experimental plots or building stress madning scale bould conceivably be as large as 1:1.

fold in detailementation is means to include interpretation of any remotety sensed data symplectic.

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Diego, California February 8-12, 1982

### COMMITTEE 2

#### DOCUMENTATION FOR HIGHER ORDER SURVEYS

This committee is the recommended continuation of the 1980 conference committee - Quality Control in 3rd and 4th Order Soil Surveys (Committee 2).

#### CHARGE 1

Develop uniform quality control quidelines (standards and documentation1 for higher order surveys.

"Higher order surveys" refers to order 3 and 4 as defined by the National Soil Survey Technical Work Planning Conference, Committee No. 7, in Orlando, Florida, January 26-31, 1975.

<u>National Cooperative Soil Survey (NCSS)</u> should follow the same basic quidelines reqardless of order of intensity. In other words, the soils mapped in an area need to be verified both in the field and in the documentation. The acceptable standards and documentation should he the same regardless of which agency does the actual field work. Current minimum documentation required in the SCS western region is spelled out in WTSC NSH Exhibit 301.4(b)(2)(ii), Attachment #2.

In addition, a Table of Minimum Documentation Requirements was developed as a result of this committee's work at the 1980 conference. This table, along with Section 300 of the National Soils Handbook, orovides adequate direction for both documentation and quality control.

The following refers to documentation to be included within the manuscript when mapping to the family level or higher.

## **Reconendations:**

- 1. Currently within the western region there are two acceptable methods of displaying a detailed pedon description and range in characteristics.
  - a. One detailed pedon description with range in characteristics to represent each family regardless of the number of phases of the family used in the survey area; or
  - b. A detailed pedon description with range in characteristics to represent each phase of the family as used in the survey area.

The committee originally recommended that if the phases being maoped within the family were different enough to be considered separate series if mapped at the series level, then they should follow option (b) listed above. If the phase criteria were not series criteria then option (al should be followed.

Two-thirds of the conference agreed with this concept. One-third preferred to use ootion (al in every case and describe the different phases within the range in characteristics. Therefore, the committee recommends leaving it up to the survey area to follow either option (a) or (b). In any case, one of the above is to be followed.

- 2. The committee recommends that a Reference Pedon description continue to he used as specified in the NSH 302.7(a)(2) as well as 603.1(a)(2)(IX). It is also recommended that when a Reference Pedon is used it he footnoted as follows: "This Reference Pedon is an example of a soil within this category. It is not necessarily representative of this soil as mapped throughout the survey area."
- 3. The committee recommends that phase naming he allowed to include items used in SOIL TAXONOMY provided these terms insure clarity while helping to maintain brevity. Phase naming using

#### CHARGE III

Propose correlation guidelines for order 1 and 2 surveys in areas already correlated as order 3 and 4 surveys.

Discussion: In areas already surveyed and correlated at 3rd and 4th order intensities, quite often there will be a need for more detailed information. If the areas are to be Dartially remapped, rather than being handled as on-site investigations, then it seems desirable to maintain the correlation process. If these areas are to be remapped, but already have been published at the 3rd or 4th order level, and there is no plan to republish, they cannot be considered as "progressive surveys" by definition (NSH Section 200). The committee does not recommend chanqing the definition of "progressive surveys" to accommodate these surveys. These areas could be handled as non-progressive surveys if the definition is modified.

# Recommendations: The committee reconends that:

- 1. The definition of non-progressive be modified to include Darts of areas previously published when the published survey no longer meets the needs of present users.
- 2. A memorandum of understanding should be Drepared explaining (1) why the area is to be remapped, (2) how it will be done, (3) who will be responsible for quality control, (4) who will be responsible for correlation, etc. The memo should also indicate that although there are no immediate plans for publication, this does not appropriate.

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Oieqo, California February R-12. 1982

# COMMITTEE 3

#### SOIL RATING CRITERIA FOR OFF-ROAD VEHICLES

#### I. Charges to the Committee

- A. Develop a bibliography related to research on effects of DRV use on soil.
- B. Evaluate existing soil limitation criteria for off-road vehicles (NSH), and revise as necessary to reflect the effects upon the soil resource. Criteria should consider nation-wide application.

#### II. Committee Activities

Concerning a bibliography. The committee gave top priority to its second charge, and did not prepare its own bibliography related to research on effects of ORV use on soils. A bibliography was published in 1978 by the U.S. Geological Survey, which is comprehensive and current up to 1977. It is: "An Annotated Bibliography of the Effects of Off-Road Vehicles on the Environment." by Robert H. Webb and Howard G. Wilshire, and published as U.S. Geological Survey Open File Report 78-149. That bibliography is also included as Appendix 2 in "Off-Road Vehicles on Public Land," by David Sheridan of the U.S. Council on Environment Quality, 1979. A book on the subject of the effects of off-road vehicles on the environment by Drs. Webb and Wilshire is now in the manuscript review stage and will include bibliographical materials up to 1980. A copy of the USGS bibliography is not included in this report because it is 28 pages long and includes more than 225 literature In addition to articles dealing specifically with the effects of ORVs on soils, the bibliography lists publications dealing with the effects of ORVs on vegetation. wildlife, compaction, recovery of soils, the effects of trampling on soils, and other items such as desert soil morphology and genesis. Also available is a list of references on the effects of ORVs on soils USDI, BLM Desert Plan Staff Special Publication, "The Effects of Disturbance on Desert Soils, Vegetation and Community Processes with Emphases on Off-Road Vehicles" which was published in 1980, and A new bibliography on the research eidted by Peter G. Rowlands. activities related to the effects of ORV use on soils would largely be a duplication of the efforts performed by Drs. Webb and Wilshire.

The Intent of this quide is to keep the use of ORVs on soils in harmony with the resource use principles of sustained yields, multiple use, and protection of environmental quality. Much of the use of ORVs is on public lands and the agencies responsible for administering these lands and the resources they support are mandated by law to abide by these resource use principles.

Soil properties and qualities were selected for this rating system which are a standard Dart of the soil characterization and soil interpretation record for any soil that has been surveyed and correlated according to the standards of the National Cooperative Soil Survey. Also, a key element was selecting properties or qualities which have nation-wide significance.

The water erosion hazard is evaluated by a modified Universal Soil Loss Equation (USLE) method. Modifications include using a slooe length factor of 1.0 for all soils, and a vegetative cover factor of 1.0 for The soil erodibility (K) factor is taken from the soil interpretation record. The rainfall and runoff (R) factor is for a specified area, and this allows the water erosion criterion to have nation-wide application. The slope gradient (S) factor is based on a medial slope length for a consociation or specific component of an All slope lengths are treated as though they association or complex. were 72.6 feet long, because the soil characterization record does not qenerally give much information about average slope lengths for mapping The cover factor is given the maximum value of units or soil ohases. 1.0 which represents bare soil, because use of soils by ORVs commonly results in unvegetated trails.

The existing guide in the NSH uses the product of the K factor and the slope gradient in percent to evaluate the water erosion hazard. This concept gives an erroneous estimate of the erosion hazard because it is based on the fallacious assumption that erosion is a linear function of slope gradient. Actually, there is a geometric relation between erosion losses and slope gradient and this is accounted for in the slope gradient (S) factor. The KXS method only represents about 1/3 the soil losses obtained by the KRS method on slopes of 8 percent, and only about 1/5 the soil losses by the KRS method on slopes of 20 to 25 percent.

The limits of the permissible soil losses for the slight, moderate and severe limitation classes depends on the tolerance (T) values for a soil, which are also part of the soil interpretation record. A soil will be classified in the slight limitation class if the estimated soil loss by the modified USLE method is less than the T value for that soil. The moderate limitation class allows the estimated soil losses to be up to twice that of the T value. Any estimated soil loss more than twice the T value will be considered as a severe limitation.

The wind erosion hazard Is rated according to the wind erosion groups which are also a standard part of the soil interpretation record for soils subject to wind erosion. Since wind erosion is not a problem when the soil surface is moist, or when the air is calm, the wind erosion hazard will not be applicable whenever the soil surface is moist, or

when the wind velocity is less than the threshold velocity

with an R factor of 25. It gives S values that correspond to various slope gradient percentages. The values in table 2 can quickly be converted to proper values for R factors other than 25 by using the multipliers given in the footnote of table 2. The relationship between the S factor and the percent slope (s) is:  $S = 0.065 + 0.045s + 0.0065s^2$ .

#### V. Recommendations

- A. The conference membership approve the committee quide for rating soil limitations for wheeled off-road vehicles as a prototype for field testing.
- B. This quide be reviewed and tested by members of the other reaions of the National Cooperative Soil Survey.
- C. The quide in Section 403.6 of the National Soils Handbook be deleted from the Handbook as soon as possible.
- D. The bibliographies on the effects of off-road vehicles on the environment by R. H. Webb and H. G. Wilshire and the BLM Desert Plan Staff be used by members of the National Cooperative Soil Survey.
- E. This committee should be continued and chaired by Marty Townsend.

### **Conwnittee Members**

- 0. Harju \*
- D. Hendricks
- H. Holdorf \*
- T. Hutchings
- L. Linnell
- C. Maesner
- D. Marriage
- G. Muckel\*
- J. Pomerening Chairman \*
- F. Reckendorf
- D. Ri chmond
- J. Rogers
- T. Ryan •
- M Singer
- M Townsend Vice Chairman \*
- J. Walker
- T. Wiggins
- D. Witte
- M Yee
- \* In attendance.

#### Attachment

Guide for Rating Soil Limitations for Wheeled Off-Road Recreational Vehicles (Proposed by Committee 3, WRTSSWPC, February 1982)

Note to reviewers: This is a draft of the narrative to accompany the quide.

Wheeled off-road vehicles include motorcycles, minibikes, trail bikes, dune huqqies, and all-terrain vehicles. They do not include snowmobiles. This guide is for rating the degree of soil limitations for use by recreational vehicles only when they are crossing the terrain in a random manner. It's not applicable for planning and designing intensive ORV use-areas, such as hillclimb areas, because that kind of activity invariably results in an irreparable reduction in soil productivity, which will require special on-the-site investigation.

Off-road vehicles can lower the natural productivity of the soils by increasing the amount of erosion and by compacting the soil. Therefore, the soil limitation ratings are based on the water erosion hazard, the wind erosion hazard, and the strength or bearing capacity of the soil. The water erosion hazard rating is based on the soil erodibility (K) factor, the slooe gradient (5) factor, and the rainfall (R) factor of the universal soil loss equation (USLE). The vegetative cover (C) factor is given a value of 1.0 because the continued use of an area by the vehicles generally results in the formation of unvegetated trails in which the surface layer of the soils is di sturbed. The wind erosion hazard rating is based on the standard wind The wind erosion hazard is only applied when the uppermost erosion groups. layer of the soil is dry and the velocity of the wind is equal to, or greater than, the threshold velocity for sand grains of 0.1 mm in diameter. The soil strength, or bearing capacity, rating is based on the unified engineering soil classification groups of the surface horizon. The soil strength ratings in this guide are for the moist and wet moisture states. The strength of most coherent soils is greater for the dry moisture state than for the moist and wet states.

The soil limitation ratings do not consider soil properties or qualities affecting the safety or health of the operator or Dotential damage to the vehicle. Nor do they consider other factors which may limit use, such as the status of the vegetation, wildlife, cultural and historic resources, access, and size and shape of the area.

Soils with a slight limitation ratinq will qenerally not suffer an irreparable reduction in their natural productivity level by the long-term, intensive use of wheeled off-road vehicles. Soils with a moderate limitation rating will suffer a significant reduction in their natural productivity level by the long-term, intensive use of wheeled off-road vehicles, but can be managed for sustained natural Droductivity by controlling the timing and intensity of use, and their natural Droductivity level can be restored through the application of relatively simple soil compaction amelioration treatments. Soils with a severe limitation generally will suffer an irreparable reduction in their natural productivity level even by the limited use of off-road vehicles.

Guide for Rating Soil Limitations for Wheeled Off-Road Vehicles (Proposed by Committee 3, Western Regional Soil Survey Work Planning Conference. February 1982)

Soil Property or Quality	Slight	Limits Moderate	Severe	
1. Water Erosion Hazard  A'=(KSR) for T of:				
a. 1 tlaclyr b. 2 t/ac/yr c. 3 t/ac/yr d. 4 t/ac/yr e. 5 t/ac/yr	<pre>&lt;1 tlaclyr &lt;2 tlaclyr &lt;3 tlaclyr &lt;4 tlaclyr &lt;5 t/ac/yr</pre>	1-2 tlaclyr 2-4 tlaclyr 3-6 <b>t/ac/yr</b> 4-a <b>t/ac/yr</b> 5-10 tlaclyr	<pre>&gt;2 tlaclyr &gt;4 tlaclyr &gt;6 tlaclyr &gt;8 t/ac/yr &gt;10 tlaclyr</pre>	
2. <u>Wind Frosion Hazard</u> 1.  Wind erosion group of surface layer	6,7,8	3,4,4L,5	1,2	
3. <u>Soil Strength</u> <b>2/</b> Unified class	GW, GP, GM, GW-GM, GW-GC, GP-GM	GC,SW,SP,SM,SC GM-GC,GP-GC, SM-SC,SW-SM,SW-SC, SP-SM,SP-SC	ML, CL, OL, MH, CH,	

Table 2. A' values by percent slope and K-factor values for an R-factor value of 251

c/4\	S					A	'=KSR fo	r K of -					
s (%)	<u> </u>	0.1	0. 15	0.17	0. 20	0. 24	0. 28	0. 32	0.37	0. 43	0. 49	0. 55	0.64
1	0. 116	0.29	0.44	0.49	0. 58	0.70	0. 81	0. 93	1. 07	1. 25	1. 42	1. 56	1.86
2	0. 181	0. 45	0.68	0.77	0. 90	1. 09	1. 27	1.45	1. 67	1. 97	2. 22	2.49	2.90
3	0. 258	0. 64	0. 97	1. 10	1. 28	1. 55	1.81	2.06	2. 39	2.77	3. 16	3. 55	4. 12
4	0. 349	0. 87	1.31	1.48	1.74	2.09	2.44	2. 79	3. 23	3.75	4. 28	4. 80	5. 58
5	0. 452	1. 13	1. 70	1. 92	2. 26	2.71	3. 16	3. 62	4. 18	4.66	5. 54	6. 22	7. 24
6	0. 569	1. 42	2. 13	2. 42	2.84	3.41	3. 98	4. 55	5. 26	6. 12	6. 97	7.82	9. 10
8	0.841	2.10	3. 15	3.75	4. 20	5. 04	5.89	6. 73	7. 78	9.04	10.3	11.6	13. 5
10	1. 16	2. 90	4. 35	4. 93	5. 80	6. 96	8. 12	9. 28	10. 7	12.5	14. 2	16.0	18. 6
12	1. 54	3. 85	5. 78	6. 54	7. 70	9. 24	10.8	12. 3	14. 2	16. 6	18. 9	21. 2	24. 6
14	1. 97	4. 92	7. 38	8. 37	9. 84	11.8	13.8	15.8	18. 2	21. 2	24. 1	27. 1	31.6
16	2.45	6. 12	9. 18	10.4	12. 2	14.7	17. 2	19. 6	22.7	26. 3	30.0	33. 7	39. 2
18	2. 98	7. 45	11. 2	12.7	14. 9	17. 9	20. 9	23.8	27.6	<b>32. 0</b>	36. 5	41.0	47.6
20	3. 56	8. 90	13. 4	15.1	17.8	2,1.4	24. 9	28. 5	32. 9	38. 3	43.6	49. 0	<b>57. 0</b>
25	5. 25	3. 1	i 9. 7	22.3	26. 2	31.5	36.8	42. 0	48.6	<b>56. 4</b>	64. 3	72. 2	84. 0
30	7. 26	8. 2	27. 2	30.8	36. 4	43.6	<b>50.8</b>	<b>58.</b> 1	67. 2	<b>78.</b> 0	88. 9	99. 8	116. 2
40	12. 3	0.8	46. 1	<b>52. 3</b>	61.6	73.8	86. 1	98. 4	113.8	132. 2	<b>150</b> . 7	169. 1	196. 8
<b>50</b>	18.6	6. 5	69.8	<b>79.</b> 0	93. 0	111.6	130. 2	148.8	172. 0	200. 0	227.8	255.8	297. 6
60	26. 2	5. 5	98. 2	111.4	131. 0	<b>' 157. 2</b>	183. 4	242.4	242. 4	281.6	321.0	360. 2	419. 2

<sup>&#</sup>x27;To convert the A' values in this table to other R values, use the following multipliers:

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<sup>2</sup> for R = 50; 3 for R = 75; 4 for R = 100; 6 for R = 150; etc.

# Appendi x

# Discussion Comments from Conference Membership

- A. Comments relative to the use of the USLE for rating the water erosion hazard.
  - 1. The "T" values published in the soil interpretation record (form 5's) are too high for many grassland soils of the Western states. value probably should never exceed 2 tons/acre/year for these grassland soils, even for the deep soils; and it probably should be less than 1 ton/acre/year for many of the soils. However, there is insufficient research results at this time to assign more accurate "T" values to soil series than those already assigned during the soil correlation process. Perhaps there should be two "T" values for each soil - one for cropland use, and another for non-cropland use. raises the question of: should there be two standards for keeping soils permanently productive - one standard for cropping, and another standard for recreational uses of the soil? The time to assign accurate or most reliable "T" values is during the soil correlation If there is a general belief that the published "T" values are inaccurate, they should be corrected on each and every soil interpretation record.
  - 2. The USLE is considered by some to be only applicable to soils being used for cropland. Others are aware that it can be accorded to soils being used for other uses, such as urban development, recreation, wildlife habitat, timber production, mining, and livestock grazing. There may be weaknesses in the K factors, R factors, C factors, etc.; but when all the alternatives are considered, the USLE approach is about the best means available for estimating the erosion losses by water erosion. The R factor component of the equation is a convenient means of designing criteria with nation-wide application.
  - 3. The wind erosion groups were generally accepted as a good means to evaluate the wind erosion hazard.
  - 4. The unified enqineering classes may not be the only criteria required to effectively evaluate soil strength or bearing capacity. The susceptibility of a soil to puddling and compaction is not related in the same amount to the unified classes for all soils. This raises the question of finding easily accessible criteria for rating soil puddling and soil compaction in a quantitative manner. The AASHTO classes were not used in this quide because they are more broadly defined than the unified classes.
  - 5. Other soil properties or qualities which were suggested as criteria for this quide are: (1) drainage class; (2) soil taxonomic classes (qreat groups); (3) soil temperature reglmes; (4) soil moisture regimes; (5) rehabitation ootential; (6) moisture state; (7) dry

strength; (8) unspecified restrictive features; (9) wildlife population; (10) plant community; (11) desert oavement; and (12) specific properties of texture, structure, organic matter content, bulk density. liquid limit, plastic limit, etc., instead of composite soil qualities such as the erosion hazard or unified enqineering class. Few, if any, class limits for the slight, moderate, and severe degrees of limitation were recommended for these additional proposed

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE. NATIONAL COOPERATIVE SOIL SURVEY

San Dieao, California February 8-12, 1982

#### COMMITTEE 4

# EDUCATIONAL REQUIREMENTS TO MEET FUTURE NCSS NEEDS

# Charqes

- 1. Review educational requirements in view of the chanqing direction of NCSS in coming years.
- 2. Propose types of university courses and/or agency training courses needed for personnel involved in the NCSS.

### Introduction

The committee report is a summary of responses by committee members and comments and information orovided by supervisory soil scientists of the Soil Conservation Service, Bureau of Land Manaqueent, Forest Service, Bureau of Indian Affairs, Bureau of Reclamation in the Western Region. Information on college and university curricula and soil science course offerings were obtained from Western Region schools and several universities in other regions. Information on SCS training courses was obtained from the Employee Development staff, WTSC, Portland. Committee reports on proceedings of the 1978 and 1980 North Central Regional Conferences, the 1980 Northeast Regional Conference, the 1980 Southern Regional Conference, Committee 1 of the 1979 National Technical Work Planning Conference of NCSS, and discussion groups of the 1978 National State Soil Scientist Workshop contained pertinent comments and information.

#### CHARGE 1

Review educational requirements in view of the chanqing direction of NCSS in coming years.

We assessed the meaning of "changing direction of NCSS" from several perspectives. Donald Robertson, in his address to the 1979 Western Regional
Conference, mentioned several items that will affect the future course of sor survey, including new National Legislation (RCA, RPA, etc.), efforts to
complete surveys on public lands, completion of mapping on private lands in some states, computer use in writin and f
increased reaction sail sotem
<del></del>

these needs. (This appears to .be a significant part of the future picture for soil survey!) The report of Committee 1 of the 1979 National NCSS Conference recommended staffing needs after the once-over soil survey is completed for:

A. Remapping some areas at higher intensity.

B. Unsite investigations, developing new interpretations.

C. Training other disciplines.

D. <u>Soil Research</u>, e.g., moisture reqimes, soil-Desticide relationships, etc.

Other comments were that: Some counties might require a soil scientist, but in low use areas, several counties would share one. The soil scientist job of the future will be very demanding with little routine work. The soil scientist will need a wide base of technical training.

The 1978 National State Soil Scientist Workshop Discussion Group 6 indicated that (1) the need for re-mapping, recorrelation, and updating of interpretations should all he made part of the state's multi-year Dlan; first priority 15 to complete the once-over soil survey; (2) there is a need for interpretive maps, interfacing with data-bank systems and soil interpretations for disposal, retention-transmission of pollutants, energy requirements for tillage,

<u>Future</u>	role	of	Soil	Scientists	wi th	chanqi nq	direction	of	NCSS:
								_	

1. Number of soil scientists attending each special training course in the past five years and those scheduled this year.

2. The proportion of soil scientists with graduate degrees. the oroportion of recently (last five years) employed soil scientists with graduate degrees, and observations about the utility of graduate training.

3. Suggestions of academic and/or agency training courses needed.

In addition, a listing and description of soils training courses were obtained from the WTSC and the National Soil Survey Laboratory, MTSC. Colleges and universities with degree programs in soil science in the Western Region and selected schools nationally were asked to send curricula requirements and list soils courses offered. The level of response to these queries range from poor to very good. The Comments received were very useful and were appreciated.

# Office of Personnel Management criteria:

The current minimum requirements for applicants to quality for the USDA-SCS (or equivalent agency) entry level soil scientist rating are stated as 15 hours (semester) of soil science plus 15 hours of other related science (biological, physical, earth). Additional evaluation is made of course hours taken under general categories such as Plant-Animal, Geology, Math.-Econ.-Stat.. and Chemistry-Physics. Some committee members feel that requirements should specify courses in soil morphology. classification, survey, and genesis. A requirement for farm experience or an equivalent work-study course was suggested. The 15 semester hour minimum of soils courses is considered too low by many, especially since the rating panels can include undefined, "closely related" courses in other disciplines.

The committee would like to have the OPM made aware of this report, and review and modify their requirements so they reflect findings of this committee. Schools offering soil science training should be informed of courses the OPM counts towards the Soil Scientist rating. Schools will be advised by the chairman that they should send their soils curricula to the OPM and request an evaluation.

#### **Courses suggested:**

The following general areas of training needs were stressed by conittee members and other respondents: (1) plant/soil/water relationships; (2) computer use-statistical analysis; (3) air photo interpetation-remote sensing-cartography; (4) communications skills; (5) operations management training; (6) plant identification-plant ecology; (7) relation of lab data and soil properties to soil behavior and interpretations for different uses; (8) geomorphology-soil/landform relationships.

Summaries of suggested courses and agency training follow. There is a degree of uncertainty (agency or academic) for some courses.

## SUGGESTIONS FOR SPECIFIC TYPES OF COURSES FROM COMMITTEE MEMBERS AND OTHERS

# qrouped under general headings specific naes of courses vary from school to school

Soil Science
'(new, additional)
*Taxonomy,
present and 1938
*Interpretations
*Sumer Camp
Internshi p
Soil Manaaement
*Genesis & Morphology
Physics
Fertility
Conservation
Urban Uses
Mi crobi ol ogy
Clay Minerology
*Soil/Plant/Water Rel.
Forest Soils
*Soil-Landscaoe Rel.
World Soils

# Math., Econ., Stat.

\*Computer Science
\*Statistics
Basic Economics
Aq. Economics
\*Resource Economics
Sampling Techniques
Land Use Planning
Advanced Mathematics
Research Methodology

# Engineering, Geology

\*Air Photo Interpret. \*Cartography **Strati graphy** \*Geomorphology \*Soil Mechanics \*Remote Sensing Enq. Properties-Soils \*Climatology Glacial Geology Mi neral ogy Surfacial Geology Geochemi stry **Irrigation** Mass Movement Soil Compaction \*Hydrol ogy Drainage Engineering

#### Chemistry, Physics

Advanced Physics Organic Chemistry Inorqanic Chemistry

# Communication, Law, Business, Sociology

**Business Law** Riparian Law **Courtroom Law** Land Use History Foreign Language \*Basic Communication **Public Relations** Human Relations \*Technical Writing \*Principles of Management Administrative Management Personnel Management **Business Management** Principles of Logic Scientific Reasoning Interdisciplinary Team Relationships

#### Plant, Animal

Plant Physiology
Botany
\*Plant Ident.-Taxonomy
Plant Ecology
\*Range Conservation
Range Plant-Soils
Forestry

<sup>\*</sup> Repeated by several people.

# SUMMARY OF RESPONSE TO QUESTION 1 ATTENDENCE OF AGENCY TRAINING COURSES - WESTERN REGION

scs - 5 States ELM - 8 States
USFS - 4 Regions RIA - 1 State
BR - Regional Summary

Course	FY 77-80	FY 1981	Planned FY 1982
Basic Soil Survey (in various states) WTSC	45	7	2
Soil Correlation WTSC	59	13	11
Soil Lab Data - use MTSC. WTSC	26	11	8
Soil Lab Data - procedures MTSC	1	0	0
Soil Mechanics - Level I WTSC	61	20	25
Soil Science Institute (Ames, Ithaca)	15	6	3
Management - Level 1 and 2	29	6	0
Management - Level 3	18	1	4
Management - Level 4 and 5	3	0	0
Basic Princ., SupervMgmt.	14	8	0
Interpretations - Soils	0	0	22
Writing Soil Manuscripts	6	1	1
Instruction-Eff. Present Instructions	1	0	1 2 5
Instruction-Training Methods	5	0	5
SCS Diqital Analysis	0	1	0
Intro. Digital Image Anal. Remote Sensing	0	0	1
PrincDiag./Treat. Alkaline Soils	1	0	1
Soils and Hydrology	1	0	0
Exec. Workshop in AgriDynamics	1	0	0
Resource Cons New Emplo. vees	3	0	6
Wetlands Training	0	2	0
Oral Communications	1	0	0
Basic Lettering-Correspondence	1	0	0
SCS Orientation	6	0 2 8 2 5 2	0
Conputers-Intro.	33	8	0?
Remote Sensing Short Course	5	2	1
Photo Interpretation	21	5	0?
Soil Survey and Uses	1		0
Soil Compaction	28	5	0
Snow Survey	1	0	0
Mass Wasting - Forest Lands	1	0	0
Land Classification	0	0	29
Earth Materials	0	0	2

Some of these courses are one-time short courses within a single agency and/or state. Some additional courses were attended that are not listed here. The numbers, of course, are quite incomplete because of the low response.

'However, there is an apparent trend of lower attendance In many courses. The National Soil Survey Laboratory training course attendance has remained high, but the number of participants from the Western Region has decreased greatly.

There is currently some concern whether the Soil Science Institute will continue. Alternative means of providing this trainins, such as a series of two-week sessions or Extension short courses, and location of this type of training at one or more universities in the Western Region, should be exolored.

# Suggested additional agency training level courses: (listed at random)

- 1. Effective presentation
- 2. Remote sensing
- 3. Interoretation
- 4. Logqing systems
  - 5. Veq. classif. & manipulation
  - 6. Data management
  - 7. Nutrient cycling, site oroductivity
  - 8. Soil/water relationships
  - 9. Forest ecology/silviculture
- 10. Water balance models
- 11. Erosion/sedim processes
- 12. Site preparation
- 13. Landing sites for timber sales

- 14. "P" lines for roads
- 15. Species adaption-forests
- 16. Locate skid trails
- 17. Rehab. strip mine areas
- 18. Locate drillingpads
- 19. Reservoir sites, management
- 20. Range site/soil correlation
- 21. Est. site productivity
- 22. Erosion control, watershed condition
- 23. Dune stabilization
- 24. Assess ag. suit. -- irrig. feas.
- 25. Soil geomorphology

With the pending relocation of the SCS Educational Development Unit in Portland. there is concern over the status of SCS conducted interagency training. This training must be continued. It is important for the SCS, as leader of the NCSS, to continue to provide training to other agencies. To minimize travel, courses could be given in a state, with participation by soil scientists from the various agencies. The involved agencies could help fund travel for the SCS instructor. If these training sessions cease, it may be difficult to reinitiate them

Other suggestions from respondents include: mandatory licensing or certification; short-term assignments to work with other disciplines; need to know about other natural resources; one-year initial training under master soil scientist; soil science curricula should emphasize basic principles and concepts, written and oral communication; new material can (sometimes) be incorporated in existing courses; need for training in interdisciplinary group interactions and relations with decision makers.

The 1980 Southern Regional Conference proceedings, Committee III, presents a suggested core curriculum for students in Soil Science. This would be worth reviewing for possible changes or additions, but appears to be a very good starting point for designing a model curriculum tailored for the Western Region.

#### Graduate training for Soil Scientists:

From the foregoing lists, it is apparent that not all "bases" will, or can, be covered in a four-year B.S. degree program One way to obtain additional course background is graduate degree work. Replies regarding the level of degrees held by present staffs show a trend of increasing proportion of staffs with advanced degrees, mainly among recent employees. Among the SCS, BLM, and FS respondents, between 20 and 30% of staff have advanced degrees. Thirty to

forty percent of those hired in the last five years have an advanced degree or a year or more of graduate training. Nearly all are Masters degrees. Comments on advanced degree work varied. Some thought future employees would need this kind of background; others said the extra training was very beneficial; some indicated it was not needed. (Nobody admitted they thought it might be detrimental.)

# Future committee work:

The committee feels this effort should continue. Items for consideration include:

- 1. Review and modification of the soil science curriculum suggested by the Southern Regional Conference.
- 2. Designate a subcommittee to investigate the advantages of agency versus academic training for different types of subject matter, and assess priorities for the different types of training.
- 3. Consider the adequacy of the present 15 semester hour minimum of soils courses to qualify for the Soil Scientist rating.
- 4. Review curriculum requirements of SSSA and ARCPACS for quidance of students in Soil Science.
- 5. Evaluate current SCS training from an interagency standoolnt. Poll the agencies to see what is needed. Note: USFS Region I (Dick Cline) has a write-up for an education program in Soil Science, and the California Soil Survey Committee has a recommended curriculum

#### Recommendations:

- 1. The suggested soil curriculum from the 1980 Southern Regional Conference should be reviewed in light of the findings of this committee, and modified to serve as a model for the Western Qegion.
- 2. Leadership should be exercised so that loss of training opportunities for employees due to fiscal constraints does not become long-lasting and irreversible, and opportunities for interagency participation in the courses be maintained and cncouraged.
- 3. The Office of Personnel Management should be advised to provide colleges and universities more specific information on courses and rating procedures considered for a high rating as Soil Scientist. Schools need this information to advise students properly and give direction to curricula development.
- 4. Agencies should consider developing multi-media training courses to be made available in lieu of traditional classroom instruction.
- 5. This committee should be continued.

# Committee Members

- J. Carey (SCS)
- M Daniels (SCS)
- L. Daugherty (NMSU) \*
  A. Ford (SCS)
- E. Gross (FS)
- G. Hartman (SCS)
- R. Hoppes (SCS) •
- W. Nettleton (SCS) \*
- R. Parsons (SCS)
- D. Pease (SCS) \*
- R. Piper (BOR)
- R. Poff (FS)
- T. Priest (SCS) \*
- J. Rasmussen (SCS) \*
- M. Rollins (BLM) •
- H. Sato (SCS) \*
- J. Simonson (OSU) Chairman \*
- A. Southard (USU) \* D. Stelling (SCS) •
- E. Wesswick (BLM) \*
- B. Wildman (UCD)
- J. Young (SCS)

# **Appended**

Proposed soil science curriculum - 1980 Southern Regional Soil Survey Conference and Proceedings.

<sup>\*</sup> In attendance.

# Appendi x

# Proposed soil science curriculum--1980 Southern Regional Soil Survey Conference and Proceedings

# Soils - qeneral requirement

Introductory Soils, with laboratory Soil Genesis and Classification Soil Morphology and Maoping Soil Chemistry Soil Physics Forest and/or Range Soils Soil Fertility and/or Fertilizers Soil and Water Conservation Drainage, Irrigation, and Erosion Control Soil Mineralogy Soil, Plant and Water Relations Soil Geography Soil Biology Soil Microbiology Soils and Land Use (Interpretations) Soil Judging Soil-Plant Analysis Saline-Alkali Soils Soil Mechanics

### Plant, Animal

Plant Identification and Taxonomy **Dendrology** Silvicultural Practices Plant Physiology Plant Ecology Crop Ecology Wildlife Ecology Introductory Botan. v Field Botany Introductory Biology Introductory Zoology Microbiology Crop Management ("Crops") Range and/or Pasture Management (Habitat1 Plant Pathology (Forest, Crop, Range. Pasture1 Feeds and Feeding (Animal Nutrition) Introductory Plant (Crop) Science

# Geology, Geography, Earth Science - modified from simply Geology

Introductory Historical Geology and/or Geography Physical Geology Physical Geography Geomorphology/Physiography Sedimentation/Sedimentology Mineral ogy/Crystal lography Hydrology/Ground Water Geology Glacial Geology Conservation/Land Use Planning Aerial Photography/Photogrammetry/Remote Sensing **Stratigraphy** Meterology/Climatology/Atmospheric Science Land Reclamation (including waste management) Petrology/Optical Minerology Geo-Chemistry Clay Minerology Urban Geology

# Mathematics, Economics, Statistics, Computer Science - Computer Science added

College Algebra (NOT remedial) College Trigonometry or Pre-calculus Mathematics Cal cul us Agricultural and General Economics **Statistics** Computer Science

# Chemistry, Physics\_

General Chemistry and laboratory Organic Chemistry and laboratory Physical Chemistry and laboratory Quantitative/Qualitative/Analytical Chemi stry General Physics and laboratory

# In addition, the following courses are considered to be highly desirable.

Communications/English - written and oral Logi c Law (applied) Management (organizational and personal) Etymology Finance (organizational and personal)

#### NOTE - Postscript from committee chairman:

A person not going to graduate school should probably be encouraged to have qeology and/or qeomorphology in preference to "additional" chemistry/physics courses. Those going to graduate school would probably want to emphasize

chemistry/physics at the undergraduate level with geology/geomorphology taken at the graduate level.

HHR

# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

San Dieqo, California February G-12, 1982

#### COMMITTEE 5

#### SOIL SURVEY INTERPRETATIONS

A Committee on Interpretations has been in existence since 1978. That .vear there were four charges and recommendations as follows:

#### <u>Charges</u>

- 1. Evaluate present methods and identify new means for making useful interpretations of multi-taxa map units.
- 2. Evaluate and comment on soil mass wasting ratings. Develop rating criteria.
- 3. Prepare a quide on how to develop potentials for crop and non-crop interpretations. Prepare list showing kind of soil information required and rating criteria.
- 4. Develop quidelines and examples of soil survey interpretations for different orders of soil survey.

#### Recommendations

1. To meet Charqe 1, the committee recommends combination tables be generated as needed from SCS-SOIIS-5 form data rather than those presently used. For example, a single table could be generated for an extensive rangeland survey area with a limited population containing column headings of septic tank absorption fields, dwellings without basements, local roads and streets, camp areas, and paths and trails. This will combine three tables (one with a single column and two with two columns each) into a single table.

The committee recommends a new form (SCS-Soils-5A) be preoared and adopted for use by all agencies making soil surveys. It can be used in addition to, or in lieu of, the present SCS-Soils-5 form. Its use will be predicated on the needs of the individual agency. It is also our recommendation definitive criteria be established by joint committee action of interagency disciplines for all interpretations recorded on the proposed form

2. The committee recommends for Charqe 2 that soil mass wasting interpretations be based on field observations of oast slope failures and related to named kinds of soils. These observations must be discussed in map unit descriptions. They can also be identified on soil maps by soot symbols.

As the committee has recommended we make soil mass wasting ratings based upon observations of past events, it was deemed unnecessary to develoo rating criteria based on soil properties. If, however, soil mass wasting potentials are developed in the future, there are sufficient soil properties discussed in the prior materials to form a nucleus of soil nroperties to start developing this interpretation rating.

In January 1980, a committee of SCS, BLM, and FS representatives met to discuss the use and application of SCS-5 for forest and rangelands. A recort of that meeting was contained in the Committee 5 handout material as Attachment 1 (the 1980 Work Conference Recort).

At the 1980 Regional Work Planning Conference, the Committee on Interpretations presented two charges and recommendations:

- 1. Develop methods of displaying interpretations of multi-taxa mapping units in order 3, 4, and 5 soil surveys.
- 2. Develop models for use of soil potential ratings for rangeland and wildland interpretations.

No single recommendation was made for Charge 1, but four alternatives were advanced:

Alternative 1: Describe mapping unit description in usual manner giving the components and percentage of the components in the unit along with inclusions. Then provide computer-generated tables. Tables can be combined into various combinations. One state consolidated tables H, J, and K into two tables. The first table had column headings: depth, USDA Texture, Unified, AASHTO, 3" fraction, clay content, soil reaction, salinity, hydrologic group, and organic matter. The second-contained depth, permeability, AWC, shrink-swell, erosion factors, corrosivity, cemented oan, bedrock, and potential frost action.

Alternative 2: Use Computer Assisted Writing (CAW) to prepare the mapping unit descriptions of associations and complexes. Other agencies can develop addendum statements to fit their special needs. These additional statements may or may not be used in the compiled manuscript. Only that part of the mapping unit planned for publication is stored in the SCS word processor, while any additional interpretative data or data for local application are stored in the cooperating agency's word processor. This method allows for all the long-range or well established interpretations to be stored along with interpretations that are being tested or only have local application.

This system has a wide application, and statements can be developed for almost all kinds of manping units and for surveys of different orders.

This system works well for soil surveys olanned for publication, hut the information is also needed quickly for plannina.

Alternative 3: Put Soil Map Unit Description in chart form These are filled out for each mapping unit. An advantage is that items are in the same place on each char% Also, there is only one set of charts oer mapping unit

with information about a mapping unit in one place, and not in several tables or text. Disadvantage is it being hand-generated. Acceptable for special needs. A computer generation of this type of display would make it easier and quicker to make.

Alternative 4: Develop ratings for each of the major components, as in Alternatives 1 through 3, but also develop a composite rating for the mapping unit. These mapping unit ratings would be based on the individual component ratings. Acceptable for technical guides or special interpretive handbooks.

No definite recommendation was made for Charge 2, except the following:

The committee recommends that charges be continued, and the respective disciplines to be involved in future committees develop the rangeland and wildland potentials.

For the 1982 meeting, the chairperson oresented the following charges:

- Charge 1 Determine the types of soil interpretations needed for forestry and range, and propose common terminology, units of measure, and criteria.
- Charge 2 Finalize SCS-5A, with instructions for submission to SCS for inclusion in NSH.
  - Charge 3 Examine procedures for interpretation of multi-taxa units.
- Charge 4 Propose procedures and minimum interpretations to facilitate transfer of knowledge for taxonomic units higher than series.

The Committee Chairman expanded the charges as follows:

Charge 1 - It may be necessary to distinquish between public land and private land. Perhaps you should consider whether it is important, at least for discussion purposes. One of the considerations is that public land management agencies retain soil scientists who are capable of making site specific interpretations.

In some cases, it may be desirable to simply examine whether existing interpretation criteria are appropriate. In other words, the interpretation may be inadequate, but the criteria for arriving at the rating may need refinement to reflect current knowledge.

- Charqe 2 SCS-5A has been oroposed in lieu of, or in conjunction with, SCS-5 for forest and rangeland interpretations. There currently are orovisions for local interpretations to he added as needed.
- Charge 3 See material from Charge 1 of the 1980 conference. It was also addressed in 1978.
- Charge 4 Current procedures allow for family interpretations on form SCS-5. The concept of variability must be recognized (at all levels).

#### **Recommendations**

#### A. It is recommended that:

- 1. The committee chairman canvas all oarticioants of this meeting for interpretations desired which are not presently on form SCS-5. Responses will need to be returned to the chairman by Aoril 1, 1982. Those submitting a proposed interpretation also submit the name(s) of persons having expertise in that area.
- 2. An ad hoc work group comprised of Dick Dierking. Loren Herman, Don Jones, Lou Langan, Jerry Latshaw, Bob Meurisse, Jack Rogers, Jerry Simonson, Byron Thomas, Larry Walker, and a forester to be named be appointed to work on criteria for the additional interpretations.
- 3. The work group material be field tested, and results be reported to this body at the next meeting.

Options:

Formal approach - Send material to be tested out as a orooosal to the National Soils Handbook.

Informal approach - Solicit volunteers from various agencies and universities to review and test.

B. It is recommended that Charges 3 and 4 be dropped.

A major problem was identified by this committee that must be solved before veqetation data can be handled interstate; that is, correlation of ecological sites, habitat types, or olant communities. It was brought out that it is SCS policy to correlate range sites; however, this is not being accomplished.

- C. A new committee of plant and soil scientists should be formed to develop a framework of quidelines for the process of correlating ecological sites (range sites, habitat types, etc.) among themselves and to soils.
  - 1. Recommended standards of taxonomy for ecological sites.
- 2. Recommended methodology, standards, and criteria for the correlation process.
  - 3. Recommended ADP procedures.
- 4. Recommended organizational requirements to administer and operate the program  ${\bf r}$
- 5. Recommended structure for a technical steering committee for overall direction. This would include the soil-vegetation team oresently being proposed by BLM and SCS.
- D. This committee identified a oroblem with agencies other than SCS in utilizing raw soils data stored in Ames, Iowa. In essence, there is a gao in compatibility of data bases and systems. We do not presently know what is available nor where it is.

The committee recommends that the committee chairperson contact each agency to develop a catalog of natural resource computer data files and make it available to cooperators in NCSS. The catalog will provide (1) purpose of the file. (2) name and phone number of person responsible for file maintenance, and (3) how the file is accessed. We recommend that this be completed by July 1982.

Charges 3 and 4 can be partially fulfilled by the following from previous committee reports:

It must be recognized that various users of soil survey data may have different needs. Some may require detailed information, while others may only require qeneral information. The primary thing that must be considered when developing soil interpretations is that they be more specific than the degree of map unit refinement and the displayed maoping detail. This has been a problem in the past. We have set up map units, whose components are at the Great Group, Subgroup, or Family level, but the interpretations are based upon a single pedon with or without defined ranges of characteristics. This is compounded by making interpretations that are more precise than the degree of mapping rather than general planning interpretations. This is wrong!

Committee 7 of the 1975 National Soil Survey Technical Work Planning Conference recommended appropriate uses for the different orders of soil surveys. The committee feels it is appropriate to restate these uses because they are pertinent to this discussion and should be considered.

1st Order Soil Surveys. Very intensive planning for purposes that require appraisal of the Soil resource of small areas. The map units are highly refined and, for example, provide accurate soils data for such uses as showing the soils of experiment plots and predicting sites for individual homes.

<u>2nd Order Soil Surveys.</u> Operations planning for purposes that require appraisal of soil resources for making predictions of the suitabilities of soils for use, their needs for management or treatment in a given use. Planning will involve predicting specific uses and treatment of discrete tracts of land but not site selection for structures.

3rd Order Soil Surveys. Applicable for general planning of county or multi-county planning districts and planning areas of extensive uses such as some extensive rangelands and arid lands. Not designed for interoretation for tracts of management size in intensive use.

4th Order Soil Surveys. Very broad planning, applicable to predicting major land uses in regional and state olanning.

It is obvious from the definitions of 1st and 2nd order soil surve vs that examples of soil survey interpretations need not be mentioned in this discussion.

The design of map units, whether phases of soil series or soil families, in 3rd order soil surveys will predicate the types of interpretations that can be made. Interpretations made in map unit descriptions should conform to the above definition.

Soil interpretations that might be considered are those concerning potential irrigated Cropland; rangeland uses including range site determinations, range seeding, methods of seeding, etc.: general planning for road location and construction; general planning for water management practices; resource materials; wildlife habitat suitability. Specific planning for road construction, irrigated cropland, and water management practices will require more detailed soil surveys and specific on-site detailed investigations.

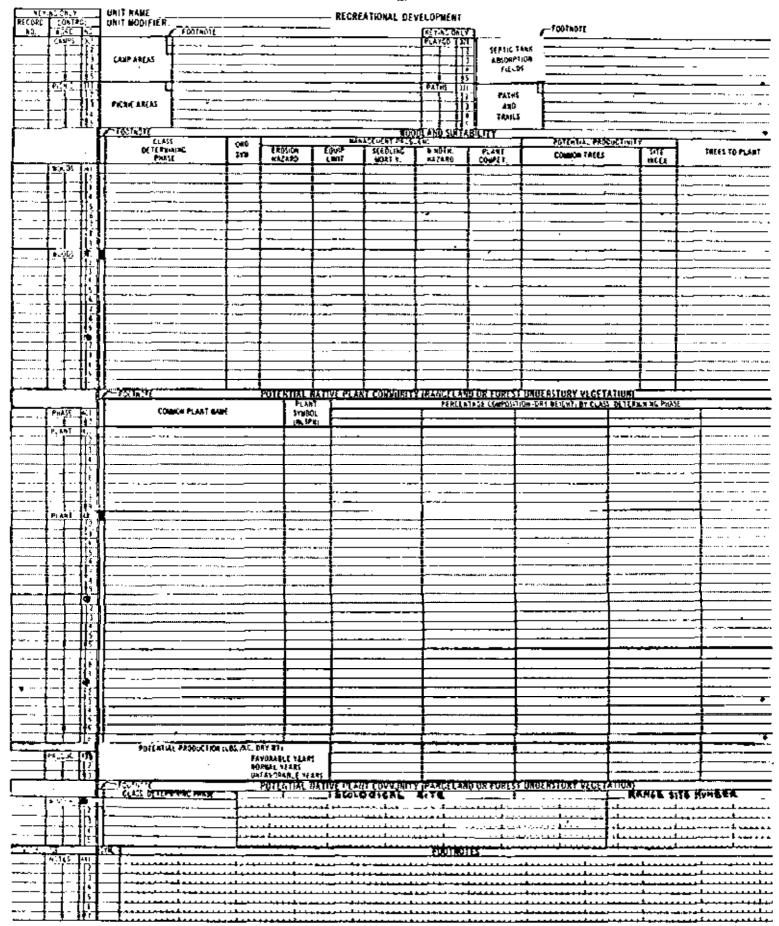
Tabular displays of interpretation data for those survey area leqends containing phases of soil series can be computer quenerated utilizing SCS-Soils-5 form data. A full array of all possible tables and columns may or may not be needed, or required. Thought should be given to selecting only those tables and columns needed to fulfill the objectives of the soil survey through its useful life. In those soil survey areas that have only a remote possibility of urbanization, thought should be given to the use of combined tables utilizing only that data that is applicable to meet the objectives of the survey. Adoption of the proposed SCS-Soils-5A form will also provide additional tabular display Dossibilities.

At the present time, tabular displays of interpretation data for those survey area leqends containing phases of families must be "hand" constructed. Interpretative data for soil families used to be recorded for computer tabular recall, This practice has been stopped for one reason or another.

Family criteria has a strong enqineering bias. As such, it lends itself to selected enqineering interpretations. Decending upon the phases recognized, it is conceivable that, within the criteria limits of the family, meaningful tabular enqineering interpretations can be presented in much the same manner as those for phases of soil series. Some engineering interpretations are beyond the Scope of map units consisting of soil families. These should not be made.

Present plans call for a review of interpretations of all members of selected families. This review will serve several purposes: (1) to determine the adequacy of Taxonomy criteria at family and higher categorical levels, (2) to test the classification of all of the family members, (3) to test and determine possible family phase criteria that might be utilized to obtain uniform interpretations at the family level (at least within major land resource areas). If these can be determined with a relatively high degree of consistency, it is entirely nossible these interpretations may once again be placed in computer storage.

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#### SUSCEPTIBILITY TO COMPACTION

Compaction is a densification process In which individual soil particles are rearranged and packed together resulting in increased bulk density and reduced macropore space. Compaction of soils reduces infiltration rates, reduces rates of saturated and unsaturated water flow through the soil, and reduces qaseous exchange. This limits amounts of water and air available for olant growth. Temperature relationships within the soil Profile may also be modified. Compacted soils typically exhibit reduced growth rates (both height and volume growth). Natural recovery of compacted soils can be very slow.

Compaction is caused by the movement of heavy machinery across the soil surface. It can also be Saused by concentrations of grazing livestock. Increased weight (lbs./in) and vibration tend to increase the degree of soil compaction.

Assumptions: Degree of compaction is highly dependent on the kind of equipment being used, number of passes, soil moisture content at the time of operation, and litter thickness. In making this rating, it will be assumed that static weight ground pressures will be equal to or exceed 13 lbs./in. Soils will be assumed to be moist (this moisture content can vary between 5 and 35 percent depending on texture). Thickness of the duff layer will be assumed to be the average for the landtype or taxonomic unit being rated.

<u>Factors Considered in Rating Soils:</u> When rating a landtype's susceptibility to compaction, the following soil factors are considered: texture, structure, coarse fragment content, internal drainage characteristics, thickness of the duff layer, and topographic conditions.

Medium textured soils tend to be the most susceptible to compaction. Coarse-textured soils are least susceptible and fine-textured soils are intermediate. Soils with single grain or weakly expressed structure are the most susceptible to compaction. Soils with greater than 45 percent by volume of coarse fragments (greater than 1 inch diameter) usually are difficult to compact. Soils which have seasonally high water tables or which have restrictions to downward water movements are often highly susceptible to compaction.

It should be noted that many of the factors which control the degree of compaction (i.e., moisture content, duff thickness, type of equipment) are highly variable or fluctuate with time. Because of this, ratings of compaction hazard for specific project plans may vary somewhat from those given in this report.

#### Classes:

Low: Soil textures tend to be in the coarse range (loamy sands, sand), coarse fragment content is generally higher than 45 percent by volume, duff layers are greater than 2 inches thick, and soils are well to excessively drained.

Moderate: Soil textures tend to be in the fine range (clays), coarse fragment content is between 25 to 45 Percent by volume, duff layers are 1 to 2 inches thick, and soils are moderately well and well drained.

High: Soil textures are in the medium range (sandy loams, loams, silt loams, silty clay loams, clay loams), coarse fragment content is less than 25 percent by volume. duff layers are less than 1 inch thick. Soils which tend to be poorly or somewhat poorly drained are also highly susceptible.

#### SUSCEPTIBILITY TO DISPLACEMENT

Displacement refers to the horizontal movement of soil caused by scraping or machinery movement. Movement of logs to a landing can also cause considerable amounts Of soil displacement. Displacement results in the removal of the duff and surface soil layer and its associated organic matter and nutrients. Removal of duff layers exposes mineral soils to forces of erosion and may result in further soil losses. Productivity on areas of displaced soils can be much less than in undisturbed soils. Vegetative recovery of these sites is often slow. Amount of displacement incurred (depth and areal extent) is highly dependent on the machine operator.

<u>Assumptions</u>: Soils will be assumed to be dry at the times the ratings are made.

Factors Considered in Rating Soils: When rating a soil's susceptibility to displacement, the following factors are considered: soil texture, structure, thickness and nature of duff layers, organic matter content, percent h.v volume of coarse fragments in the surface soil, internal drainage characteristics, and ground cover density.

Soils in finer textural classes with well developed structure exhibit a high degree of cohesiveness and are not as subject to displacement as are coarser-textured soils with little structural development. High organic matter contents are often associated with high degrees of structural development. Thick duff layers protect soils from forces which tend to displace them Large amounts of coarse fragments tend to dissipate displacement forces. Well to excessively-drained soils may be somewhat coarse-textured and tend to displace easily.

#### Classes:

Low: Soil textures are generally in the fine range (silty clay loams, silty clays, clay loams, clays), structure is well developed, duff layers (01 and 02) are commonly greater than 2 inches thick, organic matter content is 4.0 percent or greater, and/or coarse fragment content is greater than 60 percent by volume.

Moderate: Soil textures are generally in the medium range (silts, silt loams, loams), structure is moderately to well developed, duff layers are 1 to 2 inches thick, organic matter content is 2.0 to 4.0 percent, and/or coarse fragment content is between 35 to 60 percent by volume.

High: Soil textures are queerally in the coarse range (sandy loams, loamy sands), structure is poorly developed, duff layers are less than 1 inch thick, organic matter content is 2.0 percent or less, and coarse fragment content is less than 35 percent by volume.

#### SUSCEPTIBILITY TO PUDDLING

Puddling occurs when soils are subjected to mechanical forces when wet, usually at or above field capacity (qreater than 25 percent moisture by weight). have clay contents qreater than 35 percent, and have coarse fraquent contents less than 30 percent by volume. Puddling occurs when individual soil structural units are destroyed by compression and shearina, and results in soils which are massive or in a nonstructural state. Air and water movement through the soil are inhibited, and vegetative recovery is slow. Soils in a puddled condition often exhibit a glazed surface and conform to the shape of tire, track, and hoof surfaces. Erosion rates are often increased in puddled soils.

Soil puddling can be caused by operation of ground-based timber harvesting equipment, off-road vehicles, and concentrations of grazing livestock.

<u>Assumption:</u> All soils will be assumed to be at or above field capacity when ratings are made. Equipment will be assumed to be standard rubber-tired skidder (static weight 13 psi) or tractor making five passes with an average load.

Factors Considered in Rating Soils: When rating a soil's susceptibility to puddling, the following factors are considered: soil texture, percent moisture by weight at field capacity, internal drainage properties, percent by volume of coarse fragments in the surface soil, and vegetation characteristics.

Puddling is usually greatest in soils with a clay content greater than 35 percent or with a moisture content of 35 to 50 percent by weight at field capacity. Excessively-drained soils do not generally have moisture contents high enough or textures fine enough for puddling to occur. Large amounts of coarse fragments within the surface soil tend to transmit compression forces through the profile. Vegetation and topography can be indicators of soil moisture regime.

#### Classes:

<u>High Potential for Puddlin</u>: Fine-textured soils with less than 30 percent coarse fragments by vo ume.

<u>Low Potential for Puddling:</u> Coarse and mediun-textured soils with greater than 30 percent coarse fragements by volume.

#### SUSCEPTIBILITY TO ROADS

Limitation ratings are given for the use of soils for construction of unimproved roads that normally lack all-weather surfacing consisting of asphalt or concrete and that are expected to carry truck or automobile traffic all year. The roads consist of (1) the underlying local soil material, whether cut or fill, that is called "the subgrade," (2) the actual road surface that is either compacted local soil material, or gravel. These roads are graded to shed water, and conventional drainage methods are orovided. With the possible exception of gravel, the roads are constructed from the soil at hand.

The properties that affect roads are those that influence the ease of excavation and qradinq, and traffic-supporting capacity. The properties that affect the ease of excavation and qradinq are depth to hard bedrock or thickness of cemented pan, depth of water table, floodinq, amount of large stones, and slope. The properties that affect traffic supporting capacity are soil stength as inferred from AASHTO classification and group index, shrink-swell action, ootential frost action, and depth to water table. Soil slippage and dustiness may be problems on certain soils.

# MOADS

<b>3</b> 01	l Property	Slight	Limit Moderate	Severe	Restrictive Feature
1.	USEA Texture			DOE	102
2.	Depth of Bedrock (in) hard soft	<u>&gt;40±1</u> >20	20-40 C20	<u>00</u>	Depth to rock
3.	Depth to Commented pen (in) Thick (>3") Thin (<3")	>40 >20	20-46 >20	<b>%</b>	Coverand per
4.	8/9/ AASHIO Group Index number	0-4	5-8	, >8	Low strangth
5.	<u>8/10/</u>	_	A4, A5 A	-6,A-7,A-8	Low strength
6.	Water Table (ft)	>60 <sup>rs</sup>	40-60	+ 46°	Ponding Matness
7.	Slope	0-30	30-60	×60 <sup>€/</sup>	Slope
a.	Flooding	Non. Protected	Rere	Common.	7loods
9.	Potential  Frost Action	Lov Hoderate	High		Trost Action
lo.	Shring-smil	iav	Moderate	High	Strink-smil
11.	1/ Prection/Nin (West PCI)	<b>(25</b>	25-50	>50	Large stones
L2.	27/ USDA Dexture	_	SIL, SI VPSL, L	_	Dusty

<sup>1/</sup> telighted everage to 40 inches

 $<sup>\</sup>frac{8}{}$  Thickest horizon between 10 and 40 inches

<sup>9/</sup> GD= (f-35) [.2 + .005 (LL-40)] + 0.1 (F-15) (PI-10) where P-I page \$200 sizes. If PK 35 and PI> 10 use only part 2 of equation. (See madian values

<sup>10/</sup> Use AASHED classification only when group index is not known

<sup>27/</sup> Disregard unless soil is in TCE, ARID or MER suborders, great groups, or subgroups

If slopes are such that hard bedrock is exposed during most excevation - reduced rating to understa.

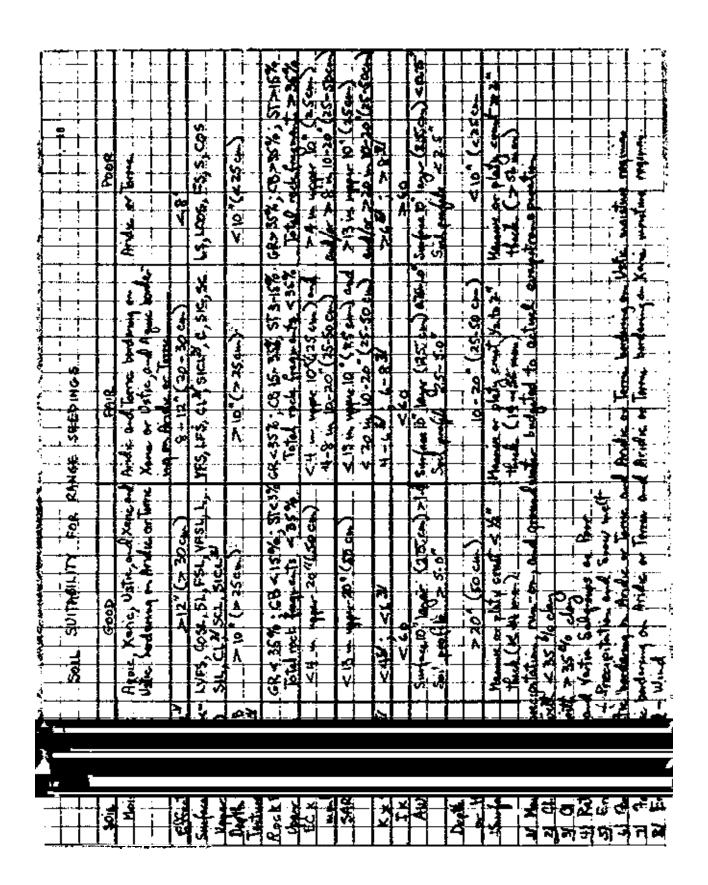
#### SUSCEPTIBILITY TO CUTBANK SLOUGHING AND RAVELING

This rating evaluates each unit for its susceptibility to sloughing or raveling after excavation. Ratings are based on cutbanks at least 6 feet high. Factors include field observations, soil and bedrock characteristics, backslope ratio, frost action, climate, and potential for revegetation.

Low: Sloughing and/or raveling is a minor problem requiring occasional road maintenance on a multi-year basis.

<u>Moderate</u>: Slouqhing and/or raveling causes some damage. Annual road maintenance is usually required.

High: Slouqhing and raveling occur at a rate that often plugs culverts and  $\overline{fills}$  inside ditches. Frequent road maintenance with heavy equipment such as front-end loader is annually required.



# 7312 - **SOILS**

Table 32

SOIL LIMITATIONS FOR MECHANICAL EQUIPMENT USAGE\*

Pactors		Rangeland Dri	111			
Affecting Use	Degree of Soil Limitation					
	Slight	Moderate	Severe			
Soil Depth	>10"	< 10°				
Stoniness Class	0, 1	2, 3	4, 5			
Rockiness Class	0	1	2, 3, 4, 5			
Slope	<121	12 - 30%	>30%			
	1	Rangeland Disc Plot	4			
Soil Depth	>20"	10 - 20"	< 10"			
Stoniness Class	0, 1	2, 3	4, 5			
Rockiness Class	0	i	2, 3, 4, 5			
Slope	< 12 <sup>1</sup> ₹	12 - 207	> 20%			

<sup>\*</sup> This is a general guide for use if local guides are not available.

#### 7312 - SOTLS

Table 34 SOIL LIMITATIONS FOR CONTOUR FURROWING, RIPPING, AND PITTING

Factors	Degree of Soil Limitation					
Affection Use	Slight	Moderate	Severe			
Texture	1,sil,cl,scl,sicl	el,fel,ec	0,10,sic,c			
Depth	>40 <sup>n</sup>	20 - 40	<20"			
Slope	< 87.	6 - 15%	>152			
Stoniness Class	0,1	2	3,4,5			
Rockiness Class	0	0	1,2			

• This is • general guide for use if local guides ue not available. Consult Teble 37, "Soil Limitations for Seeding," if ooding is contemplated following the mechanical treatment.

Table 35

#### SOIL LIMITATIONS FOR TRENCHING\*

Factors	Degree of Soil Limitation					
Affecting tree	Slight	Moderate	Severe			
Texture	1,sil,cl,ecl,sicl	sl,fel,vfel,sc	s,ls,sic,c			
Depth to bedrock	> 40"	20 - 40"	<b>₹</b> 20"			
Slope	< 30 <sub>7</sub>	30 - 507.	> 50%			
Stoniaese Class	0,1	2	3,4,5			
Rockiness Class	<u> </u>	1	2,3,4			
Exchangeble Sodium LCSP	<8	8 - 15	> 15			

<sup>\*</sup> This is • general guide for we if local guides are not available.

# POTENTIAL NATIVE PLANT COMMUNITY (Rangeland or Woodland) (Block 500)

# **Ecological Site**

Enter the ecological site name using the generic coding of the dominant olant species in the following order: tree-shrub-grass or grass-like for each significantly different plant community as identified by class determining The first line entry (501) is for the first woodland or rangeland plant community, second line entry for the second woodland or rangeland olant community, etc.

Each ecological site name will not exceed six (6) olant species. All tree, shrub, and grass or grass-like species groups are separated by a hyphen (-1 and the species within these groups are separated by a slash (/).

PIPO-PUTR/AMAL-FEID/CAGE Example: ARAR- AGSP/PONE

The source document for plant names and coding is National Handbook of Plant Names, Title Number 430, August 25, 1981, Part 610. 430 VI.

# Ecological Site Number

Enter the coordinated and correlated ecological site number.

# Committee Members

- E. Alexander (FS)
- **G.** Anderson SCS)
- 0. Carleton [FS] •
- J. Carley (SCS)
- T. Collins (FS) •
- A. Erickson (SCS)
- L. Fletcher (SCS) •
- R. Heil (CSU) \*
- L. Herman (FS) Acting Chairman \*
- s. Howes (FS)
- H. Ikawa (UH) \*
- R. Klink (BIA) \*
- L. Langan (SCS)
- G. Latshaw (SCS) •
- G. Madenford (BLM) \*
- J. Mallory (COF) \*
  H. Maxwell (SCS)
- R. Meurisse (FS) Chairman
- G. Nielson (MSC) •
- In attendance.

- Jack Rogers (SCS) \*
- R. Roudabush (BLM) •
- H. Summerfield (FS)
- B. Thomas (BLM) •

#### Other Disciplines

- R. Buttery (FS, Ecologist)
- G. Davies (FS, Forester)
- S. Finch (SCS. Forester)
- D. Fulton (SCS, Range)
  R. Jackson (FS, Forester)
- R. Kerr (BLM, Wildlife) \*
- R. Nelson (SCS, Engineering)
- W. Sauerwein (SCS, Forester)
- A. Strobe1 (BLM Range)
- L. Walker (BLM, Range) \*

# LABORATORY ANALYSES WORKSHOP SUMMARY REPORT Bill Allardice, Chairman

Quickly reviewing the various procedures used by the laboratories we see that extractable cations are determined from NH<sub>4</sub>OAC extracts in all labs. The majority of labs use wet digestion to determine the ½ carbon while one lab uses the induction furnace. The ceramic plate was used by all labs to determine the ½ bar moisture content of soils, and the pressure membrane apparatus or the 15 bar ceramic plate and extractor was used to determine the 15 bar moisture holding capacity. (Currently the University of California, Davis, and the National Soil Survey Laboratory are examining 200 soils to determine if any significant difference exists between the two types of equipment.) All labs currently use sieves to determine the sand fractions but vary on the use of the hydrometer or the pipette for clay analysis. The majority of labs remove organic matter with hydrogen peroxide or sodium-hypochlorite followed by oven drying at 105°C before disoersion with Na. One lab dispersed the soil with Na without any additional treatment. A variety of procedures are used for pH-1:1 H<sub>2</sub>O followed by 1:2 CaCl<sub>2</sub>, 1:2 H<sub>2</sub>O, 1:5 H<sub>2</sub>O, saturated paste, and KCl and/or NaF.

Three methods are used to determine bulk density: paraffin clod, saran clod and the sand/cone method. Some labs used all three methods decending upon their research needs++ Generally Jackson's diagnostic procedures are used for clay mineralogy - Mq saturation, glycerol solvation, KC1 saturation, and various heat treatments. Variations do occur and range from no treatment to complete treatment which includes NaOAc, H<sub>2</sub>O<sub>2</sub>, and dithionite (for free iron removal) as pretreatments prior to the diagnostic treatments.

The cation exchange capacity (CEC) was the determination of greatest concern (although extractable cations with NH ACC should be viewed in the same light). Generally the committee felt that there should be three "standard" methods for the determination of cation exchange capacity taking into account soil mineralogy, salts and soil reaction-factors which can influence the choice of the extractant. Reference was made to the Variable Charge conference held in New Zealand and the search for a solution to the problem of CEC determination on soils with variable charge. These problems are of considerable interest to California and Hawaii. The opinion of the workshop was that a neutral salt should be used which would allow the extractant to closely follow the pH of the soil without becoming fixed in the structure of the clay mineral.

#### **Summary of Concerns**

# 1. Cation Exchange Capacity

effect of pH dependent charges (in acid soils) effect of extractant on lime or qyosum effect of exchange cation on clay structure

#### 2. Extractable Bases

effect of extractant on primary minerals solubility of lime or gypsum in the extractant structural effect of extracting cation on clay

# 3. Clay Analyses

impact of oven drying on dispersion of the clay minerals (oven drying can cause irreversable collapse of clay) diagnostic procedures used to identify clay minerals

4. 15 bar water retension-pressure membrane apparatus vs. 15 bar ceramic olate

Finally, we need to assess our reasons for selection of an analytical procedure. Does the selected method provide the most accurate measurement of the parameter of interest? Is the selected method cost-effective? What would the impact be if the existing method was revised?

If you are involved in laboratory analyses, and were unable to attend the workshop, please feel free to update the table on "Current Methods" and return it to the chairman of the Laboratory Analyses Workshop.

#### Recommendations

- A. That the National Soil Survey Committee review laboratory methods charqing the National Soil Survey Laboratory with the responsibility of reviewing current methods used in soil characterization (such as, cation exchange on soils with variable charge) and determine if any appropriate new analytical methods are warranted. New methods should serve both classification and agronomic interests.
- B. That the National Soil Survey Laboratory should provide all cooperating laboratories with examples of their data base file systw <u>presently</u> in use; outlining such items as: the coding system, file names, record length, headings, and the column numbers and width, etc.
- C. That the data base management system should be accessable to the cooperating laboratories involved in the National Cooperative Soil Survey program in a manner which would provide a usable interchange of data.
- D. That the Laboratory Analyses Workshop be recognized as a continuing committee of the conference with the following name and charges:
  - Committee Application of Laboratory Methods to Soil Classification and Agronomic Interests
  - Charge 1 Review current methods of soil analyses with respect to their effectiveness in identifying soil properties.
  - Charge 2 Evaluate new methods of soil analyses and make recommendations to the Western Regional Work Planning Conference.
  - Charge 3 Communicate problems and solutions to problems encountered in soil characterization analyses.
  - Charge 4 Establish minimum standards for laboratory procedures.

(This recommendation was approved.)

## Conference Members in Attendance

- W Allardice (UCD) Chairman
- G. Brockman (BR)
- M Fosberg (UI)
- O. Harju (BR)
  H. Ikawa (UH)

- D. Jones (BIA)
  D. Nettleton (SCS)
  J. Nielsen (MSU)
  J. Simonson (OSU)

- A. Southard (USU)

## Laboratory Analyses Workshop - Western States - Current Methods -

Texture <b>Clay</b>	рĦ	CEC X €	Carbon Bulk Density Mineralogy
1.	1:5 CaCl <sub>2</sub>	NH <sub>4</sub> OAc Wet di	gestion Wax clod
2. Pipette H <sub>2</sub> O <sub>2</sub> , O.D. Na <sup>†</sup>	1:1 H <sub>2</sub> O + CaCl <sub>2</sub> +1:2 .01 M CaCl <sub>2</sub>	NH <sub>4</sub> OAc, NaOAc KCl+ΣBases Exch H +ΣBases (2)	
3. Pipette or Hydrometer Chlorox, Na		NaOAc	Paraffin clod
4. Pipette H <sub>2</sub> O <sub>2</sub> , O.D. Na	Sat. Paste	NH <sub>4</sub> OAc	
5. Pipette H <sub>2</sub> O <sub>2</sub> , O.D. Na	1:1 H <sub>2</sub> 0 KC1 NaF		
6. Hydrometer (Day)	sat. Paste	<b>,</b>	l Thiesen
7. Pipette H <sub>2</sub> O <sub>2</sub> , O.D. NaOAc	1:2 H <sub>2</sub> O		ı <b>n</b>
8. Pipette			

(1) <u>pH</u>

## THE PENNSYLVANIA STATE UNIVERSITY

119 TYSON BUILDING UNIVERSITY PARK. PENNSYLVANIA 16802

College of Agriculture Department of Agronomy

Date: January 23, 1981

Ref:

Ed Ciolkosr From

To: Steve Holzhev. Ben Hajek, Dick Rust, and Lerov Daugherty

Subject: Charges of the Soil Science Society of America Div. S-5

Soil Characterization Standardization Committee

I presented the four charges listed below as our conittee charges to the 1980 S-5 business meeting in Detroit. There was not very much response at the meeting or afterward on the charges with the exception of the possibility of the committee getting involved in recommending or establishing a certification program for soil characterization laboratories (see attached letter from Jerry Presently I do not think the committee should take on such a challenge. In fact between now and the 1981 ASA meetings in Atlanta I would like to concentrate our efforts on charges two and three. At the time of the Atlanta meetings we can review our progress and chart the course for future work.

### **Charges:**

- 1. Compile a listing of soil characterization laboratories that are involved in the National Cooperation Soil Survey Program
- 2. Collect references or data on comparative studies of soil characterization This may give a better perspective on the expected variation in these type of data.
- 3. Collect and disseminate information on the availability of standard samples for characterization analyses.
- Encourage comparative soil characterization studies, particularly the more 4. difficult types such as clod-bulk density, 1/3 bar water and COLE.

Listed below are the information I have on charges two and three. Please add to correct or complete these listings.

Charge 2 Collect references or data on comparative studies of soil characterization data

Title: Northeast Soil Characterization Study 1.

Richard Cronce, Agronomy Dept., 119 Tyson Bldg., Penn State University. University Park, PA 16802

Ciolkosz, E. J. (Ed.) 1980. Proceedings of the 1980 Northeast Cooperative Soil Survey Conference, Agronomy Series No. 65. Agronomy Dept., Penn State University, University Park, PA 16802

Richard Cronce, address given under author

A report of a nine lab comparative soil characterization study Remarks: on ten soil samples. Only <2 mm material was analyzed. A continuation of this study is planned.

2. Title: Northcentral Region Laboratory Study

Author: Ref:

Contact Person: Dick Rust, Dept. of Soil Science, Univ. of Minn.,

St. Paul, M 55101

Remarks: Ten soil samples were analyzed by eight soil characterization

laboratories; as yet no report has been prepared.

3. Title: Compilation of Data for CSSC Reference Soil Samples Author: J. A. McKeaque, B. H. Sheldrick and J. G. Desjardins

Ref: See title and authors. 1978. Soil Research Institute. Central

Experimental Farm, Ottawa, Ontario, Canada K1A OC6.

Contact Person: J. A. MéKeague

Remarks: Twenty four laboratories participated

4. Title: Standariiation of Laboratory Procedures for Improving Soil

**Correlation Efforts** 

Author: Ref:

Contact Person: International Soil Museum, P.O. Box 353, 6700 AJ

Wageningen, The Netherlands

Remarks:

5. Title: Northeast Soil Mineralogy Study

Author: Ref:

**Contact Person:** 

Remarks:

6. Title: Western Region Soil Mineralogy Study

Author: Ref:

**Contact Person:** 

**Remarks:** 

Charge 3 Collect and disseminate information on the availability of standard

samples for soil characterization analyses.

1. Title: National Bureau of Standards Set. Address:

Cost:

Remarks: Set of samples collected and developed by the Soil Sample Bank

Committee of Soil Science Society of America.

2. Title: Canadian Soil Set

Address: Cost: Remarks:

One last item In the early 1970's there was a SSSA Div. S-5 Soil Characterization Committee. The achievements of the committee were: 1) they compiled a listing of laboratories that were doing soil analyses, but apparently the listing was not distributed, and 2) a soil characterization symposium was organized at the 1973 SSSA Las Vegas Meeting, but the proceedings of the symposium were not published by the society as a special publication.

cc: F. P. 'Miller, T. E. Fenton and J. D. Nichols

In addition three references are given below on studies of analyses which aren't standard soil characterization analyses. We may want to include them in our final report.

- 1. Bowman, W. S., G. H. Faye, R. Sutarno. J. A. McKeague and H. Kodama. 1979. New CCRMP Reference Soils S0-1 to S0-4. Geostandards Newsletter 3:109-113.
- 2. Crock, J. G. and R. C. Sever-son. 1980. Four Reference Soil and Rock Samples for Measuring Element Availability in the Western Energy Regions. USGS Cir. 841.
- 3. McKeague, J. A. et al. 1980. Estimating Illuvial Clay in Soils by Micromorphology. Soil Sci. 129:386-388.

EC: bba

Attachment

cc: -F. P. Miller, T. E. Fenton and J. D. Nichols

## THE PENNSYLVANIA STATE UNIVERSITY

119 TYSON BUILDING
UNIVERSITY PARK, PENNSYLVANIA 16802

College of Agriculture
Department of Agronomy

Date: October 23, 1981

From Ed Ciolkosz

To: Steve Holzhey, Ben Hajek, Dick Rust, and Leroy Daugherty

Subj: Atlanta Meeting Report of the Soil Science Society of America Div. S-5 Soil Characterization Standardization Committee

In my memo of January 23. 1981 (see attached photocopy), I listed four charges of our committee and indicated that we would concentrate our efforts on charges two and three. Also listed in that memo was our first attempt at that effort. Given below is our second effort. I suggest that at the Atlanta meetin we propose that our committee (at'the business meeting of Div. S-54 be dissolved after we have summarized the information in charges one and two for publication as a note in the Soil Science Society of America Journal. I believe a reasonable time for dissolution would be mid-1982. If you have any comments on this course of action please contact me. Also if you can fill in some of the missing information or add additional information please let me know.

<u>Charge 2</u> Collect references or data on comparative studies of soil characterization data (only studies of more than two labs are included).

1. Title: Northeast Soil Characterization Study

Author: Richard Cronce, Agronomy Dept., 119 Tyson Bldg., Penn State University, University Park, PA 16802

Ref: Ciolkosz, E. J. (Ed.) 1980. Proceedings of the 1980 Northeast Cooperative Soil Survey Conference, Agronomy Series No. 65.

Agronomy Dept., Penn State University, University Park, PA 16802

Contact Person: Richard Cronce, address given under author

Remarks: A report of a nine lab comparative soil characterization study on ten soil Samples. Only <2 mm material was analyzed. A continuation of this study is underway, and one additional lab has been added. A final report is planned for mid-1982.

2. Title: Northcentral Region Laboratory Study

Author: Ref:

Contact Person: Dick Rust, Dept. of Soil Science, Univ. of Minn.,

St. Paul, M 55101

Remarks: Ten soil samples were analyzed by eight soil characterization

laboratories; as yet no report has been prepared.

3. Title: Compilation of Data for CSSC Reference Soil Samples
Author: J. A. McKeague, B. H. Sheldrick and J. G. Desjardins
Ref: See title and authors. 1978. Soil Research Institute. Central
Experimental Farm, Ottawa, Ontario, Canada K1A OC6.
Contact Person: J. A. McKeague

Remarks: Twenty four laboratories participated

4. Title: Standardization of Laboratory Procedures for Improving Soil Correlation Efforts

Author: Ref:

Contact Person: W. G. Sombroek, International Soil Museum, P. O. Box 353, 6700 A. J. Wageningen, The Netherlands

Remarks: Fifteen to seventeen labs are analyzing about ten soil samples. Results are scheduled for summary in 1982.

5. Title: The Determination of Particle Size Distribution in Soil: A Collaborative Study
Author: J. L. O. Jones, J. J. Kay, J. Park, and C. K. Bishop

Ref: See title and authors. 1980. J. Sci. Food Agric. 31:724-729

Remarks: Eight soil samples were analyzed by twelve labs.

-6. Title: Comparison of Analytical Data From Four Soil Laboratories on Three Soils of the Kindaruma Area in Kenya

Author: W. G. Sombroek

Ref: Title and author above. 1978. Proceedings of the First International Soil Classification Workshop. Ed. 0.1. Nc.

F. H. Beinroth. Rio de Janeiro. EMBRAPA.

7.

8.

#### Charge 3

1.

2.

## NORTHEAST SOIL CHARACTERIZATION STUDY

Richard Cronce - Director, Soil Characterization Laboratory, The Pennsylvania State University

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Table 1. Soil samples analyzed and their taxonomic classification.

Series	Hori zon	Classification		
Groveton Groveton	Ap B2ir	coarse-loamy, mixed, frigid Typic Haplorthod		
Hagerstown Hagerstown	AP B2	fine, mixed, mesic, Typic Hapludalf		
Gilpin Gilpin	Ap 82	fine-loamy, mixed, mesic, Typic Hapludult		
Honeoye	B2	fine-loamy, mixed, mesic. Glossoboric Hapludalf		
Vergennes	АР	very fine, illitic, mesic. Glossaquic Hapludalf		
Vergennes	<b>B2</b>			
Sassafras	B2	fine-loamy, siliceous, mesic Typic Hapludult		

Table 2. Soil characterization labs involved in the study.

University of Rhode Island SCS National Soil Survey Laboratory Argonne National Laboratory University of Maine University of Massachusetts The Pennsylvania State University Cornell University University of Maryland West Virginia University

#### **Results and Discussion**

Statistical levels of significance resulting from a statistical analysis are useo to determine the probability of finding real differences in the data. The statistical levels of significance indicate that if you say there is a difference between two populations, you might be wrong 5% of the time (0.05 level) or 1% of the time (0.01 level). The other possibility is that there is no significant difference (NS) between the populations. Values of F are calculated to determine the level of significance and, in general, the larger the F value, the greater will be the significance of the factor. Tables 3, 4 and 5 show the F values and statistical levels of significance of the experimental factors for each of the soil parameters analyzed. The data show that there were highly significant differences (0.01 level) between labs in the determinations of sand, silt, clay, organic carbon, 15 atmospheric moisture, Ca, K, H, CEC. percent base saturation, and pH in H<sub>2</sub>O, 1 N KC1 and 0.01 M CaCl<sub>2</sub>. There were significant differences (0.05 level) between labs in the

F values and the statistical levels of significance of the experimental factors for sand. silt, clay. organic carbon, and 15 atm moisture.

	Sand		Silt		Clay		organ Carbo		15 atr Moistu	
Factor	F	Sig	F	Sig	F	Sig	F	Sig	F	Sig
Lab	14. 01	**	7. 17	• *	3. 32	• *	3.67	**	10. 51	• *
Rep(Lab)	1. 11	NS	0. 41	NS	0. 80	NS	0.63	NS	3. 77	• *
Soil	12984. 21	• *	2921. 38	**	3227. 91	• *	2829. 46	• *	1181. 43	• *
Lab X Soil	20. 02	• *	8. 28	• *	5. 92	**	9. 25	**	11. 25	• '

F valuer and statistical levels of significance of the experimental factors for Table 4. Ca, Hg, Na, K. and H.

	Ca		Mg		Na -		K		н	
Factor	F	Sig	F	Sig	F	Sig	F	Sig	F	Siq
Lab	31. 22	**	2. 89	•	1. 81	' NS	26.62	##	31.85	**
Rep(Lab)	6. 89	**	0. 31	NS	1. 89	NS	1. 92	NS	0. 81	NS
Soil	1453. 59	**	2102. 82	• *	485.92	**	211. 94	• *	637.47	**
Lab X Soil	22.87	thrub.	40. 30	**	76.02	**	15.69	**	3.34	*

**<sup>\*</sup>**■ Significant at 0.05 level.

F values and the statistical levels of significance of the experimental factors for CEC, %B.S., and soil pH in  $H_2O$ , in KCL and 0.01M CaCL2. Table 5.

				На		
	CEC	<b>%</b> B.S.	H20	IN KCL	0.01M CaCL2	
Factor	F Sig		F Sig	F Sig	F Sig	
Lab	10. 30 • *	46.55	20.60 **	4.62	12.84 • *	
Rep(Lab)	0.67 NS	6.62 • *	4.63 • *	7.90 • *	20.72 • *	
Soi1	949.36	1648.51 • *	1215.38 **	865.79 • *	1687.73 • *	
Lab X Soil	12.38 • *	7.82 • *	13. 95 • *	lb. 10 • *	<b>26.37</b> • *	

<sup>• \*</sup> Significant at 0.05 level. \*\* \* Significant at 0.01 level. NS = Not significant.

<sup>\*\* =</sup> Significant at 0.01 level.

NS ■ Not significant.

<sup>\* \*</sup> Significant at .05 level.

\* \* Significant at .01 level.

NS = Not Significant.

determination of Mg. There was no significant difference between labs for the determination of Na. There were no significant differences between the replications within labs (Rep(Lab)) for sand, silt, clay, organic carbon, Mg, Na, K, H, and CEC. There were highly significant differences between the replications within labs for 15 atm moisture, Ca, percent base saturation, and pH in  $H_2O$ , 1 N KC1 and 0.01 M CaCl2. There were highly significant differences between the soil samples for all parameters determined. There was also a highly significant lab x soil interaction for all parameters determined.

The reported values and the general non-significance of the replication within a lab (Rep(Lab)) factor indicates that the replication of an analysis within a soil characterization lab contributes the least amount of variability to the data. Because of the relatively close grouping of the data within any one lab, the individual groupings in the data from several labs can be distinguished from each other. This causes the data from the labs to be statistically different when compared to each other. Some differences in the data due to labs is expected due to minor differences in methodology and other common sources of analytical variability such as varying lab technique.

The fact that statistically significant differences between labs exists must be interpreted in perspective with the particular reason for the analysis. Whether or not these differences are of practical significance will depend on the levels of a parameter that wish to be differentiated. In other words, the range in values that exist due to the variability in the lab analysis must be compared to the desired level of difference to be determined in the soil samples to be analyzed.

Tables 6, 7 and 8 show the average values obtained by the individual soil characterization labs for each soil parameter determined. These values are the average of all the soil samples analyzed. The tables also show the average deviation from the mean in the analysis for each individual lab (shown as a ± figure). The small letters indicate whether or not the average analytical results from one lab differ significantly from that of another lab. The mean values at the bottom of the tables are the averages of all soils and all labs. The average deviation from this mean indicates the expected variability in the data upon repeated analysis of a single sample by any one of the labs involved. Data not followed by ± symbols indicates the sample was not run in duplicate and blanks (no data) indicate no analyses was perfoned.

The data from Tables 6, 7 and 8 can be utilized as follows. When comparing data generated by two labs, for example, the clay data from lab 1 to clay data from lab 4 (Table 6), you have to consider that there will be an inherent difference in the data of up to 2.9 percent clay due to the differences between these two labs and that the data from labs 1 and 4 will themselves vary by 1.4 and 2.3 percent, respectively. Therefore, a difference of less than 3 percent clay is probably not a real difference when comparing data fmm these two labs. As a result, it is meaningless to try to differentiate soils by using a less than 3 percent clay difference when considering data from these two labs.

The data show that the individual soil characterization labs differ somewhat in their ability to reproduce each others data. The general trend

Table 6. Sand. silt, clay, organic carbon, and 15 atm moisture data for individual laboratories over all soils. Column values followed by the same letter indicate no significant difference at the 0.05 level using Duncan's multiple range test.

	Percent							
Lab	Sand	Silt	Clay	Org. Carbon	15 atm Mbist.			
'1	<b>21.4 ± 1.3</b> a	54.2 <b>± 1.7 b</b>	24. 4 ± 1. 4 b	1. 23 ± 0. 20 a	12.70 ± 2.15 b			
2	23. 2 ± 2. 1 b	54.3 ± 2.6 b	22.5 ± 2.1 a	1.28 ± 0.05 a	11.12 ± 1.07 a			
3				1.99 ± 0.17 d				
4	25.9 ± 0.9 cd	62.6 ± 2.9 b	21.5 ± 2.3 a	1. 23 ± 0. 15 a	13. 12 ± 0. 64 b			
5	24.3 ± 1.4 bc	53.3 <b>±</b> 2.3 b	22.4 ± 1.5 a	1.42 ± 0.09 b	10. 24 ± 0. 45 a			
6				<b>1.74</b> C				
7	20.7 ± 0.7 a	56.7 ± 3.3 c	22.6 ± 3.0 a	1. 22 ± 0. 13 a	12.61 ± 0.77 b			
8	25. 7 cd	52. 2 b	22. 1 a					
9	27. 5 d	<b>46.</b> 7 a	25. 7 b		10.73 ± 0.90 a			
MEAN	23.7 ± 1.28 (5.42)	53.5 ± 2.55 (4.8%)	22.6 ± 2.07 (9.1%)	1. 35 ± 0. 13 (9. 6%)	11.75 ± 1.02 (8.7%)			

Table 7. Ca. Mg, Na. K and H data for individual laboratories over all soils. Column values followed by the Same letter indicate no significant differences at the 0.05 level using Duncan's multiple range test.

			meg./100 gm		
lab	Ca	Mg	Na	К	Н
1	6.61 ± 0.31 b	1.49 ± 0.14 b	0.08 ± 0.01 ab	0. 18 ± 0. 02 ab	9. 10 ± 1. 72 c
2	5. 13 ± 1.81 a	1.60 ± 0.11 b	0. 12 ± 0. 04 b	0. 21 ± 0. 04 b	9.18 ± 1.29 c
3	5.08 ± 0.76 a	0.37 ± 0.02 a	0.06 ± 0.03 ab	0. 17 ± 0. 02 ab	16.60 ± 1.40 d
4	<b>9.36</b> C	1.68 b	0. 15 b	<b>0.42</b>	7. <b>09</b> a
5	8. 12 ± 0. 67 c	1.80 ± 0.39 b	0.01 ± 0.00 a	0. 12 ± 0. 04 a	8.08 ± 0.66 b
6	<b>9. 36</b> C	1. 67 b	0. 10 ab	0. 19 ab	
7	11.32 ± 0.74 d	2.37 ± 0.11 c	0.08 ± 0.02 ab	0.36 ± 0.00 c	7. 50 <b>2</b> 0. 75 ab
8					
9					
MEAN	7. 45 ± 0. 86 (11. 511)	1.61 ± 0.15 (9.31)	0.08 ± 0.02 (25%)	0. 22 ± 0. 02 (9. 12)	9. 16 ± 1. 16 (12. 7:)

	рН

is that a couple of labs are significantly lower than the rest, a grouping of 3 or 4 labs are not significantly different from each other, and a couple of labs are significantly higher than the rest. Again, the ranges and groupings vary with the particular analysis. The ability of the individual labs to reproduce their own data also varied and the relative precision of an individual lab as compared to the other laboratories varied with the particular analysis. This type of information was generated primarily to be used by the individual labs in an evaluation of their own performance.

Over all labs involved in the analysis the variability in the data varied with the particular analysis. The sand contents of the soil samples showed an average deviation of  $\pm 1.28\%$  (5.4% relative), the silt contents deviated by  $\pm 2.55\%$  (4.8% relative) and the clay contents deviated by  $\pm 2.07\%$  (9.1% relative). The organic carbon and 15 atmospheric moisture contents showed average deviations of 20.13% (9.6% relative) and  $\pm 1.02\%$  (8.7% relative), respectively.

The exchangeable Ca data for the soil samples varied by  $\pm 0.86$  meq/100 g (11.5% relative), Mg by i0.15 meq/100 g (9.3% relative), Na by  $\pm 0.02$  meq/100 g (25.0% relative), K by  $\pm 0.02$  meq/100 g (9.1% relative) and extractable H by i1.16 meq/100 g (12.7% relative). The cation exchange capacity values varied by i1.66 meq/100 g (8.8% relative) and the percent base saturation varied by  $\pm 4.05\%$  (8.0% relative). The pH values in H20, 1 N KC1 and 0.01 M CaC12 varied by  $\pm 0.15$  (2.5% relative), 0.16 (3.3% relative) and 0.21 (3.8% relative) pH unit, respectively.

This information is valuable in the assessment of soil characterization data. Instead of making decisions based only on the absolute values reported, it must be considered that values, as determined by one or more soil characterization labs, may vary within certain known limits. These mean ± values given at the bottom of tables 6. 7 and 8 give the range that any given piece of soils data may have. For example, if you characterize a soil and find that the percent base saturation is 30 percent, this study shows that in reality, due to the variability in the lab data, the true value may range by ±4.05 percent, or from 26 to 34 percent. if the clay percentage in the particle size control section is shown to be 25 percent, in reality this percentage ranges by ±2.07 percent or from 23 to 27 percent.

The average relative variations in the data (shown in parentheses at the bottom of Tables 6, 7 and 8) may be misleading in that if the absolute variability in the data remains constant with varying levels of a particular parameter, then the relative variability will vary greatly. In order to investigate this relationship the average deviations from the mean were plotted against the corresponding levels of several of the parameters determined. The parameters investigated were soil pH, the percent sand, silt and clay, extractable acidity, and percent base saturation. Soil pH was investigated due to its wide use in soil interpretation. The other parameters were investigated because of their importance in soil classification.

A linear regression equation was then determined (Table 9) for each set of data and the regression line was plotted (Figures 1-4) to show the trend in the data. The regression coefficients (R2 values) were calculated

(Table 9) to examine how much of the variation in the data is explained by the regression equations, F tests (Table 9) were performed to see if the relationships in the data were significant.

Figure 1 gives the plots of the average deviation from the mean in the data versus the percent sand, silt and clay. The figure also shows the resultant regression line for each parameter. The regression analysis (Table 9) shows that due to the wide spread in the data around the lines, there is no significant linear relationship between the average deviation in the data and the level of sand or clay. There is, however, a significant relationship at the 5 percent level between the average deviation in the data and the percent silt. The regression equation describing this line is shown in Table 9. Although this relationship is significant at the .03 level there is still considerable scatter in the data as indicated by the relatively low R squared value of 0.45. An exact fit of the data would give an R squared value of 1.00, and an R square value of greater than 0.70 or 0.80 is normally thought to indicate good relationships in data. The data does show, however, that as the level of silt increases, there is a corresponding increase in the variability of the data.

Figure 2 gives the plots of the average deviation from the mean in the data versus the pH in H2O. 1 N KCl, and 0.01 M CaC12. The figure also shows the resultant linear regression line for each parameter. The regression analysis (Table 9) shows that significant relationships exist between the average deviation from the mean and the level of the soil This is true for all three methods of determining the soil pH. This relationship was stronger for the soil pH in H20 ( $R^2 = 0.68$  and significant at the 0.01 level) than for the soil pH in 1 N KCl ( $\mathbb{R}^2$  = 0.48 and significant at 0.02 level) or the soil pH in 0.01 M CaC12 (R2 =0.41 and significant at 0.05 level). Although the relatively low R<sup>2</sup> values indicate considerable noise in the data, all three pH methods show that as the pH level increases there is a corresponding increase in the average deviation from the mean. This is expected because as the pH of the soil approaches the neutral point, the system is often less buffered and therefore more prone to noise in the data. These results indicate that when reviewing soil pH data by any of these three methods, we can be more confident in soil. PH values in the strongly or very strongly acid range than for those in the neutral or slightly alkaline This fact might also be considered when attempting to estimate the percent base saturation by using soil pH values.

Figure 3 shows the plot of the average deviation from the mean versus the level of extractable H and the resultant linear regression line through these points. The regression analysis (Table 9) shows that this relationship was the strongest of all the parameters investigated ( $R^2 = 0.79$  and significant at 0.01 level). The linear regression equation describing the line on Figure 3 states that as the level of extractable H increases, there is a corresponding increase in the variability of the data. This is of particular importance because of the use of the extractable H value in calculating the percent base saturation using the sum of the cations method. This trend in the data is also transferred to the base saturation data as a result of the calculations.

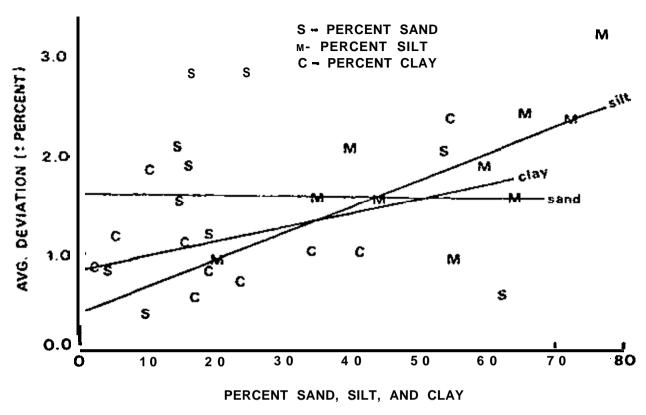


Figure 1. Average deviation from the mean in the data versus the percent sand, silt and clay, and the resultant linear regression line through the points.

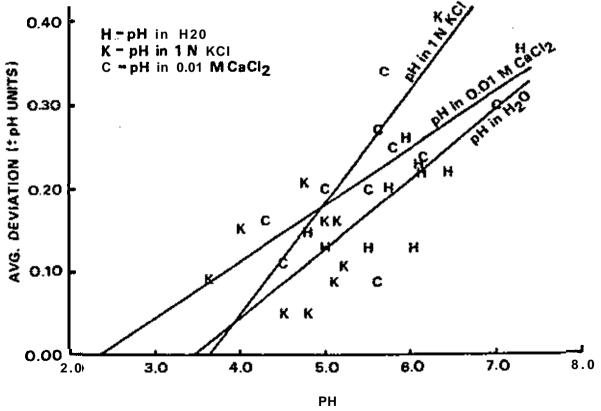


Figure 2. Average deviation from the mean in the data versus the pHin HQ.1 N KCL and 0.01 M CaCl and the resultant linear regression line through the points.

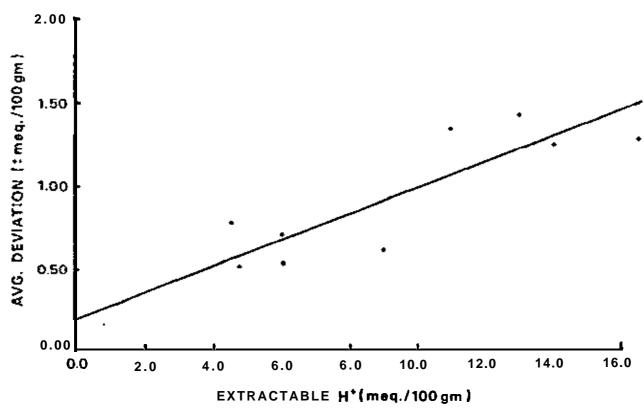


Figure 3. Average deviation from the mean in the data versus the level of extractable H and the resultant linear regression line through the points.

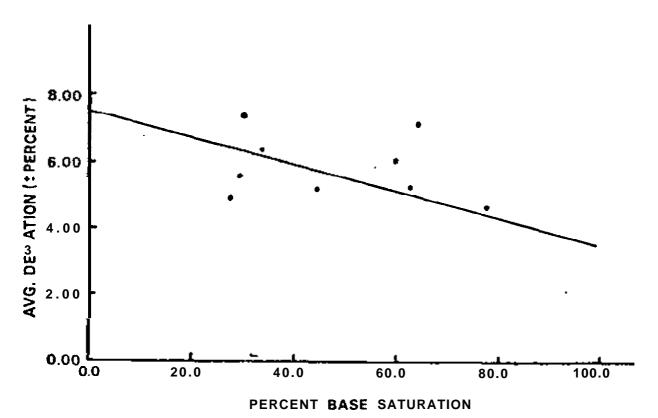


Figure 4. Average deviation from the mean in the data versus the percent base saturation and the resultant linear regression line through the points.

Figure 4 shows the plot of the average deviation from the mean versus the percent base saturation and the resultant linear regression line through the points. The regression analysis (Table 9) shows that although there was considerable noise in the relationship ( $\mathbb{R}^2 = 0.37$ ). the relationship of increasing variability in the data with lower base saturation is significant at the 0.07 level. The regression equation as well as the raw data (Figure 4) indicate that we can be less confident in taxonomic breaks around the 35 percent base saturation point than at the 60 percent base saturation points, both of which are used in our At 35 percent base saturation the average present taxonomic system deviation from the mean is approximately ±6%. This variability should be considered when considering problems involving the alfisol-ultisol break as often occur in the setting up of mapping legends and during correlation procedures.

The investigations of the variability versus the level of the parameter indicates that for the parameters investigated, several show significant changes in the average deviation in the data with the level of the parameter and several did not. Because of the varying effects this will have on the average relative variability in the data with the level of the parameter, the average relative variabilities reported in this study are probably only useful in the comparison of the precision of one type of analysis to another. In this respect the analysis performed in this study may be placed in three groups. The expected relative variability in an analysis of silt or pH in H2O, 1 N KC1 or 0.01 M CaCl2 is less than 5 percent. The expected variability in an analysis of sand, clay, organic carbon, 15 atmosphere moisture, Mg, K, CEC, and percent base saturation ranges from 5 to 10 percent. An analysis of Ca, Na and H may vary by more than 10 percent.

As has been discussed, there were significant relationships between the average deviation from the mean and the level of the parameter for the soil pH by all three methods, the percent silt, the extractable H, and the percent base saturation. When reviewing these types of data, the estimate of the variability in the lab data can be further refined through the use of the regression equations given in Table 9. For example, a soil with an extractable H value of 3 meq/100 g will vary by  $\pm 0.44$  meq/100 g (eq. 1).

eq. 1: 
$$0.20 + (0.079)(3 \text{ meg/}100 \text{ g}) = \pm 0.44 \text{ meg/}100 \text{ g}$$

However, a sample with, an extractable H value of 10 meq/100 g will vary by  $\pm 0.99$  meq/100 g (eq. 2).

eq. 2: 
$$0.20 + (0.079)(10 \text{ meg/}100 \text{ g}) = \pm 0.99 \text{ meg/}100 \text{ g}$$
.

Tables 10, 11 and 12 show the average analysis for each of the 10 soil samples analyzed by the labs in this study. The tables also give the average deviation in the data for every parameter of every soil. The data show that the different soils vary greatly from each other in **most** of the characteristics determined. Because of this wide range in natural variability as compared to the relatively small variability due to the analytical methods, all of the soils were found to be significantly different from all other soils about 83 percent of the time.

Table IO. Sand. silt, clay. organic carbon and 15 atm moisture data for individual soils over all laboratories. Column values followed by the same letter indicate no significant difference at the 0.05 level using Duncan's multiple range test.

			Percent		
Soil	Sand	Silt	Clay	Org. Carbon	15 Atm Moist
Gmveton Ap	16.9 ± 2.8 d	77.0 ± 3.1 J	6.1 ± 1.2 b	3.94 ± 0.15 h	13.81 ± 1.50 f
Groveton B2ir	25.2 ± 2.8 f	72.5 ± 2.3 i	2.3 ± 0.9 a	1.59 ± 0.11 f	7. 42 ± 0. 61 b
Hagerstwn Ap	14.3 ± 2.1 c	65.9 ± 2.4 h	19.8 ± 0.8 f	1.44 ± 0.22 <b>e</b>	9. 92 ± 0. 83 d
Hagerstwn B2	14.3 ± 1.6 c	44.2 ± 1.5 d	41.5 ± 1.0 i	0.15 ± 0.02 a	15.50 ± 0.48 g
Gilpin Ap	19.2 ± 1.2 <b>e</b>	63.7 <b>1</b> .5 g	17.1 ± 0.6 e	1.60 ± 0.07 f	9.27 ± 0.94 c
Gilpin 82	16.5 ± 1.8 d	60.1 ± 1.8 f	23.3 ± 0.7 g	0.29 ± 0.02 b	11. 16 ± 0. 92 e
Honeoye 82	53.3 ± 2.0 9	35.3 ± 1.6 b	11.4 ± 1.8 c	0.62 ± 0.04 d	6. 32 ± 0. 37 a
Vergennes Ap	9.0 ± 0.4 b	56.0 ± 0.8 e	34.2 ± 1.0 h	2.55 ± 0.15 g	16.65 ± 1.98 h
Vergennes B2	4.1 ± 0.8 a	40.6 ± 2.1 c	55.3 ± 2.3 j	$0.53 \pm 0.04 \text{ c}$	<b>21.10 ± 0.91</b> i
Sassafras 82	52.7 ± 0.6 h	21.3 ± 0.8 a	16.0 ± 1.1 d	0.23 ± 0.02 b	6.38 ± 0.35 a

Table 11. Ca. Mg, Na, K and H data for individual soils over all laboratories. Column values followed by the same letter indicate no significant difference at the 0.05 level using Duncan's multiple range test.

	meq/100 gm					
Soil	Ca	Но	Na	К	н	
Gmveton A9	11.72 ± 1.92 g	1.37 ± 0.20 d				
Groveton 82	4.01 <b>±</b> 0.76 b	0.70 <b>±</b> 0.11 c				
Hagerstown Ap	4.79 ± 1.03 C					
Hagerstwn 82	4.22 ± 0.86 b					
Gilpin Ap	7.98 ± 1.65 e					
Cilpin 82	7.49 ± 1.47 d					
Honeoy <b>e</b> B2	9.58 ± 2.56 f					
Vergennes Ap	11.79 ± 2.23 g					
<b>Yer</b> gennes B2	15. 29 <b>2</b> 2. 74 h					
Sassafras B2	1.61 ± 0.59 a					

Table 12. CEC, % Base Saturation. and pH in  $H_2O$ , in KCL and in 0.01 M CaC12 data for individual soils over all laboratories. Column values followed by the same letter indicate no significant difference at the 0.05 level using Duncan's multiple range test.

	CEC % Base		На			
Soil	(meq/100 gm)	* Base Saturation	H <sub>2</sub> 0	IN KCL	0. 01 M CaCL2	
Groveton Ap	29.71 ± 1.28 h	44.45 ± 5.27 e	6.02 ± 0.13 f	5.18 ± 0.11 f	5.64 ± 0.09 e	
Groveton B2ir	18.77 ± 0.72 f	26.90 ± 4.92 a	6.09 ± 0.22 g	4.99 ± 0.16 e	5.71 <b>±</b> 0.34 f	
Hagerstown Ap	16.53 ± 1.12 d	33.66 ± 6.43 d	5.47 <b>± 0.13</b> c	4.49 ± 0.05 c	5. 16 <b>±</b> 0. 21 c	
Hagerstown B2	17.48 ± 0.99 e	28.27 ± 5.57 b	4.77 ± 0.15 a	3.59 ± 0.09 a	4.30 ± 0.16 a	
Gilpin Ap	14.75 ± 1.56 c	59.13 ± 6.06 f	6.11 ± 0.22 g	5.13 ± 0.09 f	5.82 ± 0.25 g	
Gilpin B2	12.90 ± 1.20 b	63.55 ± 7.04 h	5.96 ± 0.26 e	4.74 ± 0.21 d	5.63 ± 0.27 e	
Honeoye B2	13.32 ± 3.35 b	93.39 ± 2.08 j	7.33 ± 0.36 1	6.32 ± 0.54 g	7.00 ± 0.32 1	
Vergennes Ap	24.07 ± 2.41 g	61.97 ± 5.26 g	5.75 ± 0.20 d	4.80 ± 0.05 d	5.50 ± 0.20 d	
Vergennes B2	29.68 ± 0.13 h	77.50 ± 4.72 <b>i</b>	6.45 ± 0.22 h	5.01 ± 0.16 e	6.17 ± 0.23 h	
Sassafras B2	6.90 ± 0.61 a	30.09 ± 7.35 c	5.02 ± 0.13 b	3.97 ± 0.15 b	4.47 ± 0.11 b	

## **Conclusions**

The soil characterization data generated by the laboratories in this study show that statistically significant differences exist between labs for all the soil parameters determined except Na. Within laboratories. however, there is a relatively high level of precision in the analytical In general, the expected average deviation in the data from any of the laboratories included in this study ranges from 5 to 10 percent but is as low as  $\pm 2.5$  percent and as high as  $\pm 25.0$  percent. The total variability in the data from within and between laboratories was found to vary somewhat with the level of several of the parameters. This fact causes the confidence in the data to also vary over the level of the parameter and this is of particular importance in the use of the extractable H and resultant percent base saturation data. Although variability exists between and within laboratories, this variability is small compared to the natural variability between the soil samples analyzed in this study and the soil samples analyzed were significantly differentiated from each other about 83 percent of the time.

## Recommendations

It is recommended that this study be continued until the 1982 work planning conference. The university personnel involved in this study should come to an agreement on what additional information is needed and the number and types of soil samples to be included in this further study. Perhaps the methods utilized by the laboratories involved should be compared in order to determine possible beneficial aspects of the methods producing the lowest variability with the least labor input.

#### Reference

Goodnight, James H. 1979. GLM Procedure Reference. <u>In</u> SAS Users Guide, 1979 edition. Jane T. Helwig and Kathryn A. Council (eds.). SAS Institute, Inc., Raleigh, N.C. pp. 237-263.

#### **APPENDIX**

#### WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FOR SOIL SURVEY

#### PURPOSE, POLICIES AND PROCEDURES

## I. Purpose of Conference

The purpose of the Western Regional Technical Work Planning Conference is to bring together Western States representatives of the National Cooperative Soil Survey for discussion of technical and scientific questions. Through the actions of committees and conference discussions, experience is summarized and clarified for the benefit of all; new areas are explored; procedures are synthesized; and ideas are exchanged and disseminated. The Conference also functions as a clearing house for recommendations and proposals received from individual members and State conferences for transmittal to the National Cooperative Soil Survey Technical Work Planning Conference.

#### II. Membership

## A. **Permanent** Voting Membership

Permanent voting members of the Conference are the following:

The SCS state soil scientist of each of the 13 western states: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

The experiment station or university soil survey leader of each of the 13 western states

The Principal Soil Correlator of the western states

One representative of the Soil Survey Laboratory at Lincoln

One representative of the Cartographic Staff, SCS, Portland

One representative of the Engineering Staff, SCS, Portland

**One** representative of each of the 7 Forest Service regional offices in the western states (Regions 1-6 and 10)

The area soil scientist from the three Bureau of Indian Affairs area office active in NCSS: Window Bock, AZ; Albuquerque, NM; Portland, OR

One representative'of the Bureau of Land Management. Denver Service Center

The state soil scientist (BLM) of 11 western states: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Wyoming

One representative of the Bureau of Reclamation

**B.** Extra, Non-Voting Membership

Special invitation may be given to a number of other individuals to participate in specific conferences. Any soil **scientist** or other technical specialist of any state or federal agency whose participation is helpful for particular objectives or projects of the Conference may be invited to attend. These extra participants do not vote on issues of Conference policy and procedures.

## III. Officers

#### A. Chairman and Co-Chairman

A chairman and co-chairman of the Conference are elected to serve for two-year terms. Elections are held during the biennial business meeting. Election of officers follows the selection of a place for the next meeting. Officers rotate among agencies. That is, the chairman-elect must be of a different agency than the past chairman. Similarly, the co-chairmen must be of a different agency than the chairman.

**Responsibilities** of the chairman include the following (specific tasks may be delegated to the co-chairman):

- 1. Planning and management of the biennial conference.
- 2. Function as a member of the Steering Committee.
- 3. Issue announcement and invitations to the Conference.
- 4. Organize the program of the Conference, select presiding chairman for the various sessions, write the program, and have copies of the program prepared and distributed.
- 5. Make necessary arrangement for lodging accommodations for Conference members, for food functions, for meeting rooms (including committee rooms), and for local transport on official functions.
- 6. Assemble the Proceedings of the Conference, have them duplicated, and distribute them.
- 7. Provide for appropriate publicity for the Conference.
- a. Preside at the business meeting of the Conference.
- 9. Maintain Conference mailing list and turn It over to incoming chairman.

Responsibilities of the co-chairman include the following:

- 1. Function as a member of the Steering Committee.
- 2. Act for the chairman in the chairman's absence or disability.
- 3. Perform duties as assigned by the chairman.

## **B.** Steering Committee

A Steering Committee assists in the planning and management of biennial meetings. including the formulation of committee memberships and selection of committee chairman. The Steering Committee consists of the following members:

Principal Soil Correlator, Western States (chairman) The Conference chairman The Conference past chairman

(See Attachment A)

#### C. Advisors

Advisors to the Conference are a SCS State Conservationist (usually, but not necessarily, from the state where the Conference is held) and an Experiment Station Director (usually, but not necessarily, from the state where the Conference is held).

#### D. Committee Chairman

Each Conference committee has a chairman. Chairmen are selected by the Steering Committee.

#### IV. Meetings

#### A. Time of Meetings

**The** Conference convenes every two years, in even-numbered years. It is held during the second full week of February.

#### B. Place of Meetings

The Conference shall be held in San Diego, California. During the biennial business meeting, invitations from the various states are considered, discussed, and voted upon. A simple majority vote decides the location of the next meeting, if it is to be other than in San Diego.

#### V. Committees

- A. Host of the work of the Conference is accomplished by duly constituted official committees.
- B. Each committee has a chairman. A secretary, or recorder, may be elected by the committee, or selected by the chairman, if necessary. Committee chairmen are selected by the Steering Committee.
- C. The kinds of **committees** and their members are determined by the Steering Committee. In making their selections, the Steering Committee makes use of expressions of interest filled by the Conference members.
- D. Each committee shall make an official report at the designated time at each biennial Conference. Committee reports shall be duplicated and copies distributed as follows:

One copy to each **member (whether** present or not) and participant in the Conference.

Fifty copies to the Staff Leader, National Cooperative Soil Survey, SCS, for distribution to other regional conferences and their committees.

Note: Chairmen of Committees are responsible for submittal of committee reports promptly to the Chairman of the Conference. The Conference Chairman is responsible for duplication and distribution of committee reports.

E. Much of the work of committees **w111**, of necessity, be conducted by correspondence **between** the time of biennial conferences. Committee chairmen are charged with responsibility for initiating and carrying forward this vork.

#### VI. Amendments

Any part of this statement for purposes, policy, and procedures may be amended at any time by simple majority vote of the Conference permanent voting membership.

#### THE STEERING COMMITTEE

of the

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FOR SOIL SURVEY

#### I. Membership

The steering Committee consists of four members, as follows:

Principal Soil **Correlator**, Western States (the chairman) The current (or forthcoming) conference chairman The current (or forthcoming) conference co-chairman The immediate past conference chairman

Membership changes upon election of officers at the regional work planning conference.

#### II. Meetings and Communications

#### A. Regular Meetings

At least one meeting is held at each regional work planning conference. Additional meetings may be scheduled by the chairman if the need arises.

#### B. Extra Meetings

Meetings of the Committee may be held between regional conferences if convenient and necessary.

#### C. Communications

Most of the Committee's communications will be in writing. Copies of all correspondence between members of the Committee shall be sent to the Chairman.

#### III. Authority and Responsibilities

#### A. Conference Members and Participants

- 1. The Steering Committee formulates policy on Conference membership and participation, but final approval or disapproval of changes in policy is by vote of the Conference.
- 2. The Steering Committee makes recommendations to the Conference for extra and special participants in specific regional conferences.

## III. Authority and Responsibilities (cont'd)

#### B. Conference **Committees** and Committee Chairmen

- 1. The Steering Committee formulates the Conference committee membership and selects committee chairmen. Insofar es possible, it 18 guided by expressions of individual preferences and interes es.
- 2. The Steering Committee is responsible for the formulation and transmittal to Committee chairmen of charges to committees.

#### C. Conference Policies

'She Steeritig Committee is responsible for the formulation of statements of Conference policy. Final approval of such statements is by vote of the Conference.

#### D. Liaison

The Steering Committee is responsible for maintaining liaison between the regional conference end (a) the Western Regional Soil Survey Work Group, (b) the Western experiment station directors, (c) the Western state conservationists, (d) the national end state offices of the Soil Conservation Service, (e) regional and national offices of the Forest Service, the Bureau of Indian Affairs, the Bureau of Land Management, and the Bureau of Reclamation, (f) the Western Soil and Water Research Committee, and (g) other cooperating and participating agencies.

## PERMANENT VOTING MEMBERSHIP LIST

of the

## WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FOR SOIL SURVEY

I.	Stat	te Soil	Scientists,	Soil	Conservation	Service:
	1.	Alaska				
	2.	Arizona				
	3	Califor	nia			
	4.	Colorad	0			
	5.	Hawaii				
	6.	Idaho				
	7.	Montana				
	8.	New Mex	ico			
	9.	Nevada				
1	10.	Oregon				
1	11.	Utah				
1	L2.					

- II. University or Experiment Station Soil Survey Leaders:
  - 1. Arizona Dr. D. M. Hendricks, Dept. of Agric. Chemistry 6 Soils, Univ. of Arizona, Tucson, Arizona 85721
  - California Dr. Gordon Huntington, Dept. of Soils & Plant Nutrition, Univ. Of California, Davis, California 95616
  - 3. Colorado Dr. R. D. **Heil,** Agronomy Dept., Colorado State University, Fort Collins, Colorado 80521
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  - 12. Wyoming Dr. Larry C. Munn, Dept. of Soils. University of Wyoming, **Laramie**, Wyoming' 82070
- III. Principal Soil Correlator or Representative:

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IV. Soil Survey Laboratory, SCS, Lincoln:

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- VII. Forest Service Western Regional Representatives:
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## NATIONAL COOPERATIVE SOIL SURVEY

## Western Regional Conference Proceedings

## San Diego, California February 1 I-1 5, 1980

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PROCEEDINGS OF . . . .

WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE

OF THE

NATIONAL COOPERATIVE SOIL SURVEY

SAN DIEGO, CALIFORNIA
FEBRUARY 11-15, 1980

# WESTERN REGIONAL TECHNICAL WORKPLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

## SAN DIEGO. CALIFORNIA

## FEBRUARY 11-18, 1980

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#### INTRODUCTION

The purpose of the Western Regional Technical Work-Planning Conference is to bring together Western States representatives of the National Cooperative Soil Survey for discussion of technical and scientific questions. Through the actions of committees and conference discussions, experience is summarized and clarified for the benefit of all; new areas are explored; procedures are synthesized; and ideas are exchanged and disseminated. The Conference also functions as a clearing house for recommendations and proposals received from individual members and State conference for transmittal to the National Cooperative Soil Survey Technical Work-Planning Conference.

This was the first time that all of the state soil scientists from the Bureau of Land Management and the area soil scientists from the Bureau of Indian Affairs active in NCSS were present *as* permanent voting members. We appreciated their active participation along with the other members.

These proceedings represent **many** of the current ideas within the western states on the acceleration of soil surveys and how to make them more usable.

> Douglas S. Pease Conference Co-chairman

#### WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE OF THE NATIONAL COOPERATIVE SOIL SURVEY

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FEBRUARY 11-15, 1980

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# Western Regional Technical Work-Planning Conference for Soil Surveys (NCSS)

# San Diego, California February 10-15, 1980

# $S_{un}$ day, February 10 -4:00-7:00 p.m. - Registration

Monday, February 1	<u>1</u>
7:30-8:00 a.m.	Registration - Kon Tiki Room
	General Session - Kon Tiki Room
	Chairman - Douglas Pease
8:00-8:20	Announcements and Introductions
8:20-8:35	welcome and Comments Gene Sullivan, Deputy State Conservationist SCS, Davis, California
8:35-8:50	Role of Management in the Soil Survey Program Richard Swenson, Assistant State Conservationist SCS, Phoenix, Arizona
8:50-9:10	Transition from Soil Mapping to Application of Soil surveys Don Robertson, Assistant Director, West Technical Service Center, SCS, Portland, Oregon
9:10-9:45	Soil Survey Program, General Remarks Klaus Flach, Assistant Administrator for Soil Survey SCS, Washington, DC
9:45-10:00	Break
10:00-10:20	Role of the Agricultural Experiment Station in the Soil Survey Ralph Young, Director of the Agricultural Experiment Station, Reno, Nevada
10:20-10:50	The State of Affairs in Soil Survey R. W. Arnold, Director, Soil Classification and Correlation, SCS, Washington, DC
10:50-11:20	Looking Ahead for the 80's - A Committee Report James Culver, State Soil Scientist, SCS, Lincoln, Nebraska

Discussion Period

11:20-12:00

12:00-1:00	Lunch				
	Chairman - Fred Peterson				
1:00-1:25	Mapping Terrestial Ecosystems Forest Service, Albuquerque, New Mexico				
1:25-2:10	Land Form Sequence in Basins Fred Peterson, Professor of Soil Science University of Nevada, Reno, Nevada				
2:10-2:30	Status Report of Erosion Measurements Gordon Huntington, Lecturer and Specialist in Soil Morphology, University of California, Davis, California				
2:30-3:00	Discussion Period				
3:00-3:15	Break				
3:15-5:00	Committee Review. of Draft Reports Committee 1 - Kon Tiki Room Committee 2 - Kon Tiki Room Committee 3 - Moana Room Committee 4 - Moana Room Committee 5 - Mai Tai Room				
Tuesday, February	12				
8:00-11:15	Discussion Groups				
11:15-12:00	Committee Chairmen meet with Recorders				
12:00-1:00	Lunch				
1:00-3:00	Discussion Groups Continued				
3:00-3:15	Break				
3:15-5:00	Committee Chairmen meet with Recorders				
Wednesday, Februar	<u>y 13</u>				
8:00-5:00	Field Trip Terry Cook, George Borst, and Dick Kover - Tour Leaders Participants will leave the motel at 8:00 a.m. by bus for a transect of soils in the northern part of San Diego County, California. The tour will give us an opportunity to observe the utility of laboratory data and the classification of the soils.				

# Thursday, February 14

	General Session - Kon Tiki Room				
	Chairman - Fred Peterson				
8:00 8:00-8:25 8:25-8:40 8:40-9:00 9:00-9:15 9:15-9:40 9:40-10:00	Agency Reports Agricultural Experiment Station - Al Southard Bureau of Indian Affairs - Henry Waugh Bureau of Land Management - Jack Chugg Forest Service - Tom Collins Soil Conservation Service - Mel Williams Water and Power Resources Service - D. Piper				
10:00-10:15	Discussion Period				
10:15-10:30	Break				
10:30-12:00	Individual Agency Meetings				
12:00-1:00	Lunch				
	General Session - Kon Tiki Room				
	Chairman - Douglas Pease				
1:00-3:00	Business Meeting				
3:00-3:15	Break				
3:15-5:00	Committees Meet with Recorders to Complete Reports  Committee 1 - Kon Tiki Room  Committee 2 - Kon Tiki Room  Committee 3 - Kon Tiki Lounge  Committee 4 - Moana Room				
Friday, February 1	<u>5</u>				
	General Session - Kon Tiki Room				
	Chairman - Fred Peterson				
8:00 8:00-8:30 8:30-9:00 9:00-9:30 9:30-10:00	Committee Reports Committee 1 - Ed Naphan Committee 2 - Dick Dirking Committee 3 - Owen Carleton Committee 4 - LeRoy Daugherty				
10:00-10:15	Break				
10:15-10:45	Committee 5 - Shelby Brownfield				
10:45-11:15	Discussion Period				
11:15	Adjourn				

# Minutes of Business Meeting

The business meeting of the Western Regional Technical Work Planning Conference for Boil surveys was held on February 14. 1980 at the Catamaran Hotel, San Diego, California.

The meeting was opened by conference chairman Douglas Pease.

The motion was made, seconded and passed to amend the constitution to have a chairman and co-chairman at future conferences, rather than a chairman and vice-chairman.

Tom Priest made a motion that San Diego, California be selected **as** the permanent location of the Western Regional Technical Work Planning **Conference**. Ed **Gross** seconded the motion. After considerable discussion the motion passed with 24 in favor and 14 opposed.

Fred Peterson made a motion to amend section IIIA of the constitution to delete the

# Transition from Soil Mapping to Application of Soil Surveys

There have been a number of new happenings since last time this group met in San Diego 2 years ago. Environmental causes have not so much lessened as other causes have accelerated in their emphasis. The energy shortage has once again become very real. Attendant to this is the question of surface mining and the ever-increasing demands for water. There is the "sagebrush rebellion," which is impacting soil scientists with respect to their access to the land to do mapping. It is impacting the soil survey from the standpoint of reduced taxes and reduced services from the states. We have recognized China and detente with Russia has cooled, which has had an impact on the amounts and kinds of exports. The priority on growing certain kinds of crops make soil interpretations relevant to that. All our agencies have new leadership; the Forest Service has a new chief; the Soil Conservation Service has a new administrator who probably will be soon identified as chief; the Denver Service Center of the BLM has changed its organization. There is now the Senior Executive Service with new kinds of leadership. There is the impact of new authorities and policy and new legislation such as those affecting the Bureau of Land Management, the Extension Service with RREA, the Forest Service with RPA, the Soil Conservation Service and USDA with the Soil and Water Resource Conservation Act of 1977, commonly called RCA. There is the first report of RCA due in 1980. A good deal of what is in that report will have been based on soils data and the National Resources There is a whole new emphasis on public involvement. USDA now has a draft resource appraisal of soil and water and related resources, a proposed program, and an Environmental Impact Statement, which addresses soil and water conservation problems. USDA will soon be calling on the public through 18 nationwide public meetings plus many more meetings within states to help decide what the soil and water conservation programs for the future will be. Through a nationwide poll conducted by Louis Harris and Associates we now have for the first time public opinion expressed through this process on what the people of this country think about soil and water conservation, its priorities, and needs for the future. encouraging response on the part of the people concerning the need for increased emphasis in the field of soil and water conservation and a commitment on the part of all the people to contribute to such a cause. USDA now has for the first time an official policy on range wherein inventory is one of the key elements.

There have been these and undoubtedly other significant happenings that I have overlooked which have a decided impact on soil surveys, and within soil surveys itself there have been changes. The increased efforts to complete soil surveys on public lands, the increased recognition of the value of computer assisted writing, the new forms of technology transfer that are being used. As of today the National

Presented at Western Regional Technical Work Planning Conference for Soil Surveys (NCSS) by Donald R. Robertson, Assistant Director, West Technical Service Center, Soil Conservation Service, Portland, Oregon, February 11, 1980.

Cooperative Soil Survey is closing in on the completion of field mapping on private land. In the State of Hawaii the soil survey is completed. In New Mexico it is nearing completion. The State of Washington is nearing completion on private land. We are seeing better data used, better correlations, better interpretations. We are seeing information received through RPA, RCA, and environmental evaluations all contributing toward better soils data as well. We are seeing an increasing rate of soil survey accomplishment on the public lands.

It seems to me all this calls for some new examinations of the status of soil surveys to assure that we make the most effective use possible of our soil survey capabilities to meet projected needs. I think we need to ask ourselves today who are we doing the soil survey for, who is our Is our clientele different in the west than other parts of the country? Is it different in the central valley of California versus the southwest desert versus the energy rich resource areas of Wyoming, Montana, and Colorado, versus the urbanizing areas around Seattle and Portland and many other locales? Mist every soil survey report look just like the last one that came off the press? Must a report covering a few large ranch operations look the same, including the number of copies, format, etc., as it does for a rapidly developing area? Should the agencies have more responsibility for their own quality control? Are the universities teaching their soil scientist aspirees that the future in soils may be less inwardly oriented toward taxonomy and nomenclature, research and self analysis, and more outward oriented toward dealing with the public and helping scientists and the public decide early on what we are making this survey for if it doesn't meet the needs How do we sell the soil survey to the people; how do we display it to the people so that they can understand it? How do we, at the same time, provide better interpretations for advancing technology?

The transition from field mapping to soil technology application is gradual, but its more imminent every day. There is an interesting and exciting new future for soil scientists who will take soil surveys more and better grounded scientifically, make better and better interpretations, massage these for the various publics and become more and more integrated. with the people who use the information to make more effective decisions. After all, decision making is the ultimate test.

To help guide us in this future effort there's the National Soil Survey
Plan and draft development. A look into the future includes a need for
more and better institutional arrangements. We need to be planning now
for a significant reorientation in our appro tatureasier soils dnts. andci apnaryns, luecisit

# Activities of WRCC - 30 - 1979

# Assembled by A.R. Southard

This report represents an abbreviated listing of the activities by

State Experiment Stations personnel related to Soil Surveys. Publications
are the Appendix II.

# Arizona

Report appended

# California

General Soils Map in progress
Field **reviews**Agricultural ratings and soil interpretations
Soil Sampling and laboratory characterization
Development of Archives and study center for official type locations
of soil series
Erodibility studies on 20 benchmark soils
Soil moisture and temperature transects

# Colorado

Publication of prime farmland maps
Soil resource data management systems
Organic matter and nutrient cycling in Agro-ecosystems of Great
Plains of the United States and Canada
Evaluation of geologic material as plant growth medium
Assessment of erosion and nutrient budgets based on "virgin soil"
characterization data

#### Hawaii

Benchmark network continues and now involves 3 soil families in Hawaii, Puerto Rico, Brazil, Indonesia, Philippines and Cameron Land evaluation for expansion **of** macadamia nut production Reclassification of Andepts under the proposed**Andisol** Order

#### Idaho

Soils atlas of the state
Range vegetation - wildlife habitat as related to soils
Loess studies
Spodosol study
Forest habitat studies
Fragipan studies

### Montana

General soils map and bulletin in final stages
Potentials and compaction hazards in forested soils
Energy requirements. for tillage
Land use map from LANDSAT imagery
Computer network in 50 counties using Flexcrop model
Computer selection of a new agresearch center
Research includes work on mine spoils, soil temperature related to
K response in wheat and soil potentials of 35 sites.
Happing of geology and geomorphology of a county prior to initiation
of a soil survey.

# New Mexico

Report appended

# Nevada

Soil sampling and characterization
Interagency training courses
Field review
Collected soil temperature in NE Nevada
Drafted interagency position papers on subjects of common interest in soil survey.

# Oregon

Field reviews
Soil sampling and characterization
Soil temperature data collection
Plant-soil relations studies in 3 sagebrush subspecies
Productivity index ratings for soil mapping units in western Oregon.
Graduate thesis-

argillic horizons with scanning electron microscope; use of cluster analysis in evaluating range sites; and genesis of hummocky soils on strip structural plains.

# Washington

Field review in 5 state forest projects Manuscript review for 2 counties Soil - forest site work in 3 counties Soil interpretations for commercial forests Research -

benchmark soils; tephra chronology; manis mastodon site; surface charge related to nutrient release from micas: stability of montmorillonite in spodic horizons; and effects of iron and aluminum coatings on surface charge.

# Wyoming

No reported activities

Appended Reports

Arizona

New Mexico

Continued progress has been made this pest year in the application of machine process satellite data to mapping soils. A thesis by Walter Lucas entitled "Relationship of Landsat Spectral Date with Earth Surface Features on Simi-Arid Rangelands" describing results of a study near Winkelman, Arizona, is essentially completed. A contract from the Coronado National Forest enabled us to produce spectral maps for about 500,000 acres of lend in the Chiricahus Mountains. Marc Kaplan, Coronado Forest Service Soil Scientist, has been utilizing this product and results to date look promising. In addition to this map, we are also generating a spectral map for the Peloncillo Mountains in extreme southeastern Arizona and southwestern New Mexico end will continue to evaluate this product to assist with the soil survey of that area. John Kelsey, Soil Scientist on the Tonto National Forest, has also been using spectral data end has made major contributions to the study.

In addition to these studies, Scott Hutchinson and Steve Levine, Soil Scientists with the Soil Conservation Service at Douglas and Tucson, respectively, have indicated an interest in investigating this technology and applying it to their survey area. We are producing spectral maps for approximately 75.000 acres of rangelands north of Douglas and are planning to work with Hutchinson in the evaluation of this information. Limited resources prohibit us from also working with Levine.

An order 2 soil survey for 3,600 acres of Papago Farms was completed. This MS a contract from the Papago Tribe and, in addition to the soil survey, involved a very detailed sampling for lab characterization and evaluating the soils for agricultural production potential. Detailed management recommendations were prepared based on the field and lab studies.

Two new studies recently initiated include the summarization of soils lab data for the State of Arizona to help us better understand Arizona soils and their properties. The evaluation of field testing kits as to their accuracy in measure ing selected soil parameters is also being carried out.

Laboratory characterization studies of important soils are continuing, The characterization work on the soils from the ponderosa pine zone of the Beaver Creek Area is nearly complete. This work represents the most in-depth comprehensive study ever made of a group of Arizona soils.

Study of the soils on Greens Peak is continuing. A paper summarizing some of the results of this research completed to date was presented at the annual meetrings of the Soil Science Society of America in Fort Collins, Colorado on August 6, 1979. Samples from additional pedons were collected including clad samples for bulk density determinations and for thin section preparation. Additional work planned on the soils from Greens Peak include micromorphology, clay mineralogy, determination of inorganic P fractions. characterization of the organic matter, charge chacterization and possibly opal phytolith determinations as our limited time and resources permit.

We are collaborating with the Southwest Rangeland and Watershed Research Center (SEA) in applying a Hicrotrac particle size analysis system to soil and watershed sediment samples. Ray Haverland, a PH.D. student, is the main person working on this.

We are also cooperating with the U. S. Geological Survey (Menlo Park) in soil chronosequence study in the Los Angeles basin. Les McFadden, a Ph.D. student in Geosciences at the University of Arizona, and also an employee of the USGS, is working on this. We are working with him in the laboratory characterization studies.

# New Mexico State University -L. A. Daugherty

A soil moisture project funded by the Soil Conservation Service has been conducted by NMSU Agricultural Experiment Station. Mean annual soil temperatures, precipitation, and soil moisture regimes were determined for four plant communities in central New Mexico, The plant communities under study included blue grams grasslands, one-seed juniper and pinyon pine woodlands. pinyon pine sod aligator juniper woodlands, and ponderosa pine forests. Soil moisture was measured with a neutron probe, and the soils of each site were classified into a soil moisture regime for each of three soil moisture control sections computed. The soil moisture control section was computed for three initial soil moisture content levels. The sites were grouped by plant community, and long-term moisture regimes were estimated for each community. The blue grama grasslands were classified into the ustollic subgroup of the aridic soil moisture regime. In lower areas of the same landscape. where water may collect or run over the site, a deep, dark surface may form. Soils in this situation were classified into the pachic subgroup of the uatic soil moisture regime. The classification of the one-seed juniper and pinyon pine woodlands ranged from the aridic to the typic subgroup of the uatic soil moisture regime. Pinyon pine and alligator juniper woodlands were classified into the same soil moisture regimes as the one-seed juniper and pinyon pine woodlands. The ponderosa pine forest soils classification ranged from the typic to the udic subgroup of the uatic soil moisture regime. All sites were classified into the mesic soil temperature regime except the lowest site in the blue grams grasslands. which was thermic. The measured soil moisture regimes agreed with the Newhall model for the blue grams grasslands site, but disagreed for the other plant communities. The sites had unusually high precipitation.

Over 100 pedona, selected jointly by the Bureau of Land Management, the Soil Conservation Service and New Mexico Agricultural Experiment Station, have been characterized. The main thrust of this project has been the characterization of soils situated on National Resources Land in Sierra, Chaves, Sandoval, Lincoln, Rio Arriba, Socorro, and Catron counties, New Mexcio. The described and sampled soils represent Aridisola, Alfiaola, Mollisols, and Entisols. The following physical and chemical analyses have been done on the samples: texture, organic carbon, nitrogen, water retention, pH, electrical conductivity, carbonates, soluble Cations, exchangeable cations, gypsum and cation exchange capacity.

**Over** 15,000 **acres have** been mapped order 2 by the NM Agricultural Experiment Station in the coal fields of northwestern New Mexico. These soils were interpreted for use as **a** source of topsoil.

NMSU representatives attend numerous field reviews of the National Cooperative Soil Survey. Laboratory support is given for on going soil moisture studies in several counties.

# Appendix II

#### Publications

# California

- Reganold, J. P. and M. J. Singer. 1979. Defining prime farmland by three land classification systems. Jour. Soil & Water Cons. Vol. 34. No. 4, pp 172-176.
- Singer. M. J. and J. Blackacd. 1978. Effect of mulching on sediment in runoff from simulated rainfall.' Soil Sci. Soc. of Am. Jour. 42 (3): 481-486.

# Reports & Working Papers -

- Howard, R. F.K. Trott and M. J. Singer. July 1979. Soil compaction and relative soil erodibility Final Report to the United States Forest Service. Dept. of Land, Air 6 Water Resources. Univ. of California, Davis.
- Singer, M. J. and J. R. Munn. 1979. Relative soil erodibility of benchmark soils annual report to the Soil Conservation Service. Dept. of Land, Air & Water Resources, University of California, Davis.
- Tanji, K.K.. et al. Nov. 1978. Sediment production and transport in Colusa Basin drainage area annual report to Environmental Protection Agency. Water Science and Engineering Paper 4016, Dept. of Land, Air & Water Resources, University of California, Davis.

### Approved Thesis -

Howard, R. J. Oct. 1979. Factors affecting compaction of 14 California upland soils. MS thesis. On file in Library, University of California, Davis.

### Montana

- 1. Morphology of a Paralithic Contact in a Soil Over Soft Sandatone. W. M. Schafer, G. A. Nielsen. and W. D. Nettleton. Soil Sci. Soc. Am. J. 43:383-386, 1979.
- 2. Soil Characterization Data: Glacier County Area and Part of **Pondera** County. J. G. Haigh, A. R. Southard, M. G. Klages, and G.A. Nielsen. SCS. Bureau of Indian Affairs, Montana Agric. **Exp.** Sta., Montana State Univ. Research Report 131, 1979.
- 3. Soil Temperature Predictions in Mountain and Foothills of Montana. L. C. **Munn** and G. A. Nielsen. Montana Agric. **Exp.** Sta., Montana State Univ., Bulletin 705, 1979.
- 4. Soil Genesis, Hydrological Properties, Root Characteristics, and Microbial Activity of 1- to 50- Year Old Stripmine Spoils. W. M. Schafer, G. A. Nielsen, D. J. Dollhopf, and K. Temple. USDA/EPA Interagency Energy/ Environment R and D Program Report, EPA 600/7-79-100. 212 p. April. 1979.
- 5. Crop Yields on Strip Mined Lands: A Comparison of Productivity on Native Soils Vs. Strip Mine Spoils. G. A. Nielsen, and E. V. **Miller.** J. of Soil and Water Conservation. (In press). 1980.
- 6. Root Biomass Calculations Using a Modified Counting Technique. **W. M.** Schafer and G. A. Nielsen. J. of Range Mgt., Vol. 33 (In press). 1980.
- 7. Genesis and Morphology of a Spoils **Chronosequence in** Southeastern Montana. W. M. Schafer and G. A. Nielsen. **Soc.** Sci. **Soc.** Am. J.. (In press).
- Soil Performance Data and Soil Potential Ratings for Corn Production; and Computer Assisted Information Delivery. Nielsen,.
   G. A. Terminal report of a sabbatical leave project. Agron.
   Series 57. The Pennsylvania State University, University Park. 1979.
- 9. Guides for Estimating Cover-soil Quality and Mine Soil Capability for Use in Coal Stripmine Reclamation in the Western States. Schafer, W. M. Reclamation Review. Vol. 2, No. 2. 1979.
- 10. Analysis of Research Needs for Soil and Land Use. Task Force.

  Joint Task Force of the Western Regional Planning Committee for

  Natural Resources. 1979.

# Nevada

### Publications:

- 1. Baumer, O. W., W. D. Nettleton, F. F. Peterson and W. J. Sauerwein. 1979. Correlation of soils and vegetation in the central part of the eastern high Sierra. Agron. Abstr., ASA 1979 Annual Meetings. p. 173. (Delivered)
- 2. **Belton,** T.. R. E. Eckert, Jr., J. L. Stephens and F. F. Peterson. 1979. Ecological relationships among range condition, site potential, and vesicular crusting soils. Delivered, 1979 **Soc.** Range **Manag.** Annual Meetings.
- 3. Eckert. R. E. Jr., M. K. Wood, W. H. Blackburn and F. F. Peterson. 1979. Impacts of off-road vehicles on infiltration and sediment production of two desert soils. J. Range Manag. 32:394-397.
- 4. Eckert. R. E. Jr., M. R. Wood, W. H. Blackburn. F. F. Peterson, J. L. Stephens and M. S. Menrisse. 1978. Effects of soil surface morphology on improvement and management of some arid and semi-arid rangeland. Proc. 1st. Intern. Rangeland Cong., pp. 299-302.

#### Utah

#### Publications:

- 1. Southard, A. R. Vegetation-Soil relationships in the middle Rocky Mountains. **Proc.** Fifth No. Amer. Forest Soils Conference. Fort Collins, Colorado.
- 2. West, N. E., R. J. **Tausch,** K. H. Rea, and A. R. Southard. Soils of the Great Basin Pinyon-Juniper Woodlands. **Proc.** Fifth No'. Amer. Forest Soils Conference. Fort Collins, Colorado.
- 3. Haigh, J. G. et al. 1979. Soil characterization data--Glacier and Ponderosa Counties, Montana. Montana Agric. Exp. Stn. Research Report 131. 39 pp.
- 4. Southard, A. R. et **al.** 1979. Important farmlands of Cache County. UAES Res. Rep. 41.
- 5. Southard, A. R. et al. 1979. Important farmlands of Salt Lake County. UAES Res. Report 43.
- 6. Southard, A. R., and H. B. Peterson. 1979. The role of Soil Taxonomy and Benchmark Soils in Technology Transfer. In **Alafua** Agric. Bull. **4(3):11:14.** West Samoa. M. **J.** Balckie, ed.

7. ·Lawton, Rick. 1979. An Investigation into the use of Cluster Analysis to identify range sites. M.S. Thesis,, Dept. of Soils & Biometeorology, Utah State University, Logan. Utah 04322.

# Washington

# Publications:

1. **Shovic,** H. F. 1979. Genesis, classification, *and* variability of the **Kitsap** 

# WESTERN REGIONAL TECHNICAL WORK-PLANNING

# **CONFERENCE FOR SOIL SURVEY (NCSS)**

San Diego, California February 14, 1980

Jack C. Chugg, Soil Scientist, Division of Resource Inventory Systems, Denver Service Center, Denver, Co.

SCS/BLM COORDINATION AND CORRELATION

FOR SOIL SURVEYS ON PUBLIC

#### LANDS THAT THE BUREAU ADMINISTERS

Mandates through legislative acts have set the course for resource inventory of the natural resources for the Bureau: FLPM for instance, states that "the Secretary shall prepare and maintain on a continuing basis an inventory of all public lands and their resources and other values.... giving priority to areas of critical environmental concern. This inventory shall be kept current so as to reflect change in condition and identify new and emerging resource and other values". (Sec 201). Further along in Section 202, the Act becomes more specific. It says, (1) "Use and observe the principles of Multiple Use, (2) Use a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic and other sciences and (3) coordinate with other federal and state agencies in land use inventory, planning and management."

This act and others has caused the Bureau to evaluate Bureau inventory systems for the natural resources that we manage. The resource data needed to develop Environmental Statements for Range and Coal as well as active plans caused the development of the Soil Vegetation Inventory Method (SVIM). This became accepted procedure for the Bureau. SVIM established policy for gathering soil and vegetation data within the Bureau. The wide range of interpretations that can be made from this data has great utility in the management of all of the nearly one half billion acres that the Bureau administers. The principles of SVIM are equally applicable without exception in Alaska and the eastern states as it is in the Western United States where lands are administered by the Bureau.

The Bureau, as a member of the National Cooperative Soil Survey, accepts the standards set forth by this organization. The purpose for this organization is to establish a common base for exchange of soil and vegetation data without duplication of effort. With this kind of charge, and the SCS's responsibility for soil correlation the coordination and quality control for soil surveys becomes a very large and difficult management problem under the restraints (funds, work force. work load; court orders, etc.) that the Bureau must operate.

Beginning in 1978, when SVIM became operational, problems in coordination and quality control in soil surveys on 131 million acres began to surface and be identified. Some of the problems were anticipated, resulting in the issuance of the Washington Office Instruction Memorandum No. 78-315. Soils-Long Range Soil Survey Work Plan. The response from the states was mixed and difficult to analyze in an orderly manner. It was not all bad because administration did respond in some manner to the most obvious deficiencies, such as, developing a scheme for quality control under an Interagency Agreement with the SCS West Technical Service Center. This established better liaison with SCS at WTSC and the Washington Office.

The Bureau now has a State Soil Scientist in all the states except for the Eastern States Office. This is to name only a few of the actions taken since 1978.

Again, in 1979 there was an issuance of Washington Office Instruction Memorandum No. 79-601, Soils-Long Range Soil Survey Work Plan. The purpose was not only to more closely identify the work load, but to identify the problems of coordination and quality control for management of soil surveys. From the analysis of the long range soil survey on a national basis the following problem areas in correlation and quality control were identified.

The most significant problem that occurs throughout all the soil surveys is quality control. Soil Conservation Service and private firms are having great difficulties in meeting the requirements of the Statement of Work (SOW). This is due, in part, to the short time frames imposed upon the completion of the soil survey for large areas by the Bureau. Some solutions to this problem will be suggested later.

The next most important problem area is locating and making available qualified soil scientists and range conservationists in sufficient numbers that can do this kind of work within the time frames imposed by the Bureau. It is indicated by the plan that if the Bureau and SCS had about 135 full time soil scientists available for mapping at a rate of 150,000 acres per season (100 days), the Bureau could meet their 20.3 million acre goal in Fiscal Year 1980. It also would require about 18 additional highly qualified, full time. soil scientists to maintain quality control and 10 more for correlation of the survey. This totals to 163. It is not a question of whether the Bureau or SCS have the numbers of soil scientists, it is how this expertise is being utilized in the Bureau's soil survey activities.

Quality control and correlation are very difficult to attain when short time frames are imposed for gathering soil and vegetation data. This problem is most evident in Wyoming, Utah, Nevada and California. The documentation procedure for soil surveys requires more time than now allowed to adequately describe, classify, interpret, and correlate named and unnamed soil series. This procedure is long and complex. When as much as one half of the Bureau lands are located in such areas of unnamed series, this intensifies the problem of quality control and correlation.

There are two actions that the Bureau could initiate to ease these problems in soil surveys as stated. These are:

- The Bureau and SCS develop a standardized statement of work **(1)** (SOW) for Interagency Agreements (SCS) and Request for Proposals (RFP) (Contracts). The Bureau, Soil Conservation Service and Contractor are basically after the same kind of soil and vegetation data everywhere without exception. There will be some flexibility intensity of mapping to allow for objectives of the soil survey. When the SOW is prepared for a soil survey area copies will be forwarded to the State Director (BLM) and to the State Conservationist (SCS) for coordination, quality control and correlation. There must be a current Memorandum of Understanding covering the soil survey area including the identification of personnel by agency responsible for the mapping, quality control, correlation, and the publication plans for the area.
- Quality control procedures for soil surveys on public lands need to be identified in the SOW for interagency agreements and in Request for Proposals (RFP) to private industry. The procedures should be the same among the states. The SCS will participate in all TEPC'S, pre-work conferences and field reviews. When the Bureau is doing in-house soil surveys, the SCS will participate in the field reviews. This is necessary to identify the principal individuals involved in the soil survey, as well as, to develop schedules and documents for each stage of progress in the survey leading to SOil and range site correlation. This kind of information should be shown in the Memorandum of Understanding for the survey area.

Based on these 2 problem areas listed above, the Bureau (Chugg) and the SCS WTSC (Dierking) have drafted a SOW to meet the minimal requirements of the National Cooperative Soil Survey. This will be circulated for review and comments. Quality control for soil survey on public lands that the Bureau administers has been addressed by a peer group headed by the State Conservationist of Utah. Their findings will be addressed at this conference.

There are several areas of concern existing between the Bureau and SCS in the areas of coordination and roles each plays in the soil surveys of the Public Lands that the Bureau administers. These concerns will be identified but not expanded on at this time. These are as follows:

- Coordination on the annual allocation of soil survey funds among the Western states based on the Bureau's long range soil survey work plan.
- 2. Coordination of soil survey reporting procedures for completion of various phases of the survey program (CASPUSS).
- 3. Role and responsibility of the BLM for quality control in Public Land soil surveys that lead to correlation by the SCS.
- 4. Role of the BLM in the publication of soil surveys where public lands are by far the dominate land status.
- 5. Procedures for the BLM to support or contribute to the laboratory phase of the soil survey.
- 6. Role of the BLM in the National Resource Inventory where sites are located on public lands that the Bureau administers.
- 7. Role of the BLM in the support of a team to study soil-plant community relationships and its interpretation for range and wildlife management. (Climax and ecological stages)
- a. Role of remote sensing as a tool in soil and vegetation surveys.
- 9. Role of the SCS in training of soil scientists from cooperating agencies.

# At the field Office level:

- 1. BLM needs to develop a catalog of statements for soil survey reports on public lands with the assistance from the SCS WTSC (CAW).
- 2. BLM needs to develop a Soil Interpretations Record for public lands with assistance from the SCS WTSC.
- 3. BLM needs to set up interagency workshops or conferences with selected groups of BLM-SCS field parties within the state to explain the concepts of the Soil Vegetation Inventory Method (SVIM) before the inventory begins in an area.

At the Service Center level:

The Division of Resource Inventory Systems has the responsibility to improve resource inventory techniques needed to achieve an integrated system of inventories Bureau-wide. Remote sensing as a tool in developing or conducting a soil survey is a technique that can be used to speed up and increase the accuracy of the survey. This Division, working with the Branch of Remote Sensing, are in the process of developing a field procedure for mappino soils on a quarter million acre test area in southwestern Idaho.

The following is a general outline of the procedure the Bureau is using for soil surveys in the test area:

- 1. Study site selection (test area) (by Oct. 1, 1975)
- 2. Ancillary data (resource data and photography)
- 3. Objective (Resource staff) (SOW)
- 4. LANDSAT (scene selection)
- 5. Preliminary classification of the scene (by Hay 1979)
- 6. Ground Truth of preliminary classification
- 7. Correct the preliminary classification
- 8. First draft classification (based on ancillary data)
- 9. First draft classification review by resource staff
- 10. Second draft classification (results of review and ancillary data). The products are developed at the same scale as the field sheets. The ancillary data includes existing data, such as soils, vegetation, geology, landform (USGS 7.5 min. quads), climate and lineaments plus the inputs of the resource expertise and ground truth.
- 11. Brief the mapping team and explain how the products were developed and suggest techniques of use. March 1980

This tool can be used to define certain soil characteristics that cannot be easily observed, such as, (a) soil boundaries in their entirety, (b) location and extent of inclusions, (c) serves as a guide for sampling homogeneous areas, and to guide the mapper in locating simular soil areas. This procedure should speed up the soil survey of the area and therefore is cost effective. It is estimated that this initial cost is one cent per acre.

The Bureau has a large soil survey work load through the next few years. Table l.- shows the magnitude of the job faced by the Bureau as well as that of the SCS on the public lands that the Bureau administers.

The Bureau's present soil scientist staff numbers about 118 (Table 2.) with a projection for fiscal year 1989 of 244. There appears to be a need for soil scientists for some time by the Bureau. Soil surveys and their interpretation are a near ending process.

There are about 189 work years (10 months) of soil scientist time planned for soil surveys on about 20 million acres of public lands administered by the Bureau in Fiscal Year 1980 Table 3. A rate of about 112,000 acres per year averaged out over several years may be a realist rate when one considers all activities that soil scientists must do to develop a soil survey for publications.

Thank you for the privilege of participating in the Western Regional Technical Work Planning Conference for Soil Survey (NCSS).

**Attachments - 3** 

- 1. Table 1
- 2. Table 2
- 3. Table 3

11.5    11.2
(11) (84) (85) 66-891  (14) SCS (374) RIM SGS (114) RIM SGS (104) RIM SGS (114)  (15) 3.1
High Sets (1984   Bild Sets (2004   NEM Sets (1984
(BS) 66-891  BLM SCS COM RIM SUS USH  1
MAN SUS UTHE -A 4.7 5.8 5.2 7.0

L/ Authortzation years (82), (83),

(85)

2/ BIM Funded

TABLE 2 - BLM SOIL SCIENTISTS PRESENT & FUTURE

OFFICE	DECEMBER 1979	Остовек 1989	FULL STAFF BY FY 3/		
ΛΛ	1	1 2			
ΛΥ	1	6	85		
AK	2	9	86		
AZ	4	14	86		
CA	10	26	89		
CO	8	16	83		
ES	0	3	83		
ID	8	24	84		
MT	11	18	84		
N V	16	19	89		
NM	14	15	82		
OR	22 51		95		
UT	11	22	84		
WY	10	19	83		

TOTAL  $118^{1/}$   $244^{2/}$ 

February 1980

1/ Number as of December 29, 1979

2/Projected numbers needed for maintenance of the soil' survey and its interpretation for activity planning, to sat lsfy the mandate of FLPMA and other acts and orders.

Office	No.
wo	1
SC	1
SO	12
DO	58
RΛ	<u>166</u>
	238

3/States will complete soll survey in this fiscal year.

TABLE 3.- WORK-YEARS OF SOIL SCIENTISTS DEVOTED TO BLM SOIL SURVEYS IN FY 80

	WORK-YEARS BY						
rate 	BLM	SCS	CON.	STATE	TOTAL	PLANNED ACRES (MILLIONS)	ACRES PER WORK-YEAR. (THOUSANDS)
AZ	4.0	7.0			11.1	2.0	182.
CA	4.5	7.5	1.0		13.0	0.7	54
co '	1.8	16.9			18.7	0.9	48
ID	7.0	14.0		4.0	25.0	2.4	96
MT	4.0	5.0			9.0	0.5	56
NV	15.4	29.0	9. 0		53.5	6.4	120
NM	11.0	2.4			13.4	1.5	112
OR	7.0	3.0			10.0	0.6	60 <sup>1</sup> /
UT	5.5	15.0	1.7		22.2	1.8	135
WY	2.9	3.8	6.6		1.3.3	3.6	271
TAL	53.2	03.6	1.8.3	4.0	189.1	20.4	108
W-Y	33.4	54.8	9.7	2.1	100.0	[	

 $<sup>\</sup>underline{1}/$  Increase soil scientists from  $\underline{10}$  to 20 to complete soil survey by 1989

Western Regional Technical Work Planning Conference for Soil Survey
San Diego, California

February 10-15, 1980

by
Thomas M. Collins
USDA Forest Service
Ogden, Utah

In the way of introduction, I em one of seven Forest Service Regional soil scientists in the western part of the United States. I have been asked to address you today on behalf of the U.S. Forest Service's Washington Office.

Mr. Kermit Larson, Forest Service Soil Scientist in the Washington Office, who would normally address you, was unable to attend this meeting.

The Forest Service has an on-going program of soil. resource inventory in the western United States. Currently, we have soil **inventories** of one intensity or another on about 61 percent of the western land area administered by the U.S. Forest Service and have targets for completion of the majority of the remainder by 1983 with some form of soil information.

We are required by law to complete our first round of Forest planning by 1985. The Chief of the Forest Service has set a due date of 1983. This has stimulated increased need and activity in the area of soil resource inventory. Most of our soil inventory planning has been short term, designed to meet specific need within 1 to 2 years ahead and probably will be until we finish this first round of Forest planning in 1983. Consequently, we have had some

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problems in responding to the Soil Conservation Service's schedule of work planning. We do recognize the importance of this planning, however, and are making efforts to schedule further ahead. We will continue to work with the Soil Conservation Service end the Federal agency toward the NCSS goal of having completed soils Information in the United States by 1998. We are seeing an increasing number of cooperative soil survey work plans being entered into and expect this trend to continue.

In the area of personnel and manpower, there are currently 211 soil scientists working in the western part of the United States. As part of that total, we have hired 32 GS 5/7 entry grade soil scientists in the western United States during the past two years and in 1980, we have projected 26 additional new hires. Most all of these will be new hires Into the Federal system. We also are using the Cooperative Education program to target additional employees for the 1980's. It should be noted that while we have increased numbers of soil scientists, a substantial number are not in soil inventory. Other demands have increased, taking up to 50 or 60 percent of our soil scientists' time. Forest Service soil scientists do a variety of soil consulting work or extension type work and are involved with technology transfer so that soils information is properly considered.

In the area of contracting, the Forest Service, in the western Region, contracted about 900,000 acres of soil inventory during 1979 and have projections for about 1 million acres in 1980. We see an increase in the area of contracting at least during the next 3 to 5 year period. In most all cases

where soil inventories have been contracted, the soil conservation service has been involved in the soil correlation.

During the past 2 years, the Forest Service has completed those National Erosion Inventory plots which were identified within National Forest boundaries. The data has been submitted to the various states for inclusion with the National data base at Ames Iowa. If future plans are to increase the reliability **or** intensity of this data base, and federal lands are to be included, we would like as much lead time as possible.

Several of our Regions are currently using various forms of automatic data processing in their soil work including the (CAW) computer assisted writing or modification of that program. We are looking with great interest at Soil Conservation Service work being done under contract with Colorado State University relating to the automation of a basic soil data base, including the soil pedon and soil interpretative data. We are going to have to develop a soil data base to meet the requirements of the planning process related to the National Forest Management Act. We can see application of

- (c) Soil erosion sedimentation.
- (d) Soil productivity studies.
- (e) Soil characterization studies.
- (f) Study to assess soil variability in soils and to develop ways of coping with this variability.

Also, soil scientists are providing technical assistance to land managers to overcome certain limitations. Soil scientists in these positions require different kinds of skills than those working in the more traditional field of soil mapping and classification. Frequently, more emphasis is needed in soil physics, soil chemistry, soil fertility, plant ecology, soil mechanics, soil biology, silviculture, geomorphology, statistics, and related subjects.

# R. Piper 1-22-80

### WATER 6 POWER RESOURCES SERVICE

- 1. Soil Science-related Activities Within the Water and Power Resources

  service Rather than try to cover all soils activities within my agency,

  I will mention only those of primary importance which have a relationship.

  to roil surveys as accomplished by WCSS cooperators.
  - a. Economic land classification for irrigation.
  - b. Drainage and reclamation of salt-affected lands on existing irrigation projects.
  - c. Engineering properties of soils related to construction activities.
  - a. Revegetation of disturbed lands.

While the Water and Power Resources Service is not a cooperator in the National Cooperative Soil Survey Program, we do make substantial use of such surveys (particularly at the less detailed levels of our investigations), and are in a position to provide a wealth of data (chemical. physical and economic) relative to our areas of investigation which would be useful to the completion and interpretation of such surveys.

2. Use of Soil Surveys in Land Classification Activities - Continued constraints on available in-house manpower, coupled with limited funding and seemingly unrealistic time limitations have forced us to make more use of soils surveys and other secondary data in the accomplishment of our land classification studies.

As you are probably aware. irrigation suitability land classification comprises not only many of those factors considered in the performance of a soil survey, but also includes consideration of substrata charcteristics, drainage factors, economic considerations, etc. Thus, it amounts to what might be considered a very specialized and detailed

interpretive soils study and, a6 such, presents Opportunities for utilisation Of NCSS surveys 66 a source of basic data.

However, it must be recognized that since the goal of a land classification study is the separation of lands into mapping units which represent relative levels of payment capacity or net farm income, the delineation of such units will not necessarily coincide with the boundaries of soil survey lapping units. Ranges of characteristic6 within soil survey mapping unit6 may well be great enough to encompass more than one land class (payment capacity range); substrata or drainage characteristics related to a particular soil survey mapping unit may differ sufficiently to result in substantially different level6 of payment capacity; or, costs of development for irrigation may vary within soil survey mapping units sufficiently to result in differing land classes within a given unit. Therefore, it is not possible to transfer soil survey delineations directly onto a land classification map. or vice-versa.

This is not to say, however, that no relationship exists. We all know that the chemical and physical characteristics of the soil profile are basic to any determinations regarding suitability of lands for specific purposes, and that these characteristics are the prime focus of soil survey activities. Thus, at least Initially, the types of data gathered are very similar for both activities. Subsequent (or concurrent) additional data gathering and application relative to specific suitability parameter6 (the amount and type of additional data gathering is dependent on the detail required or the Intensity of land classification) results in arefined land classification specifically related to irrigation suitability.

Detailed irrigation suitability studies **require** a considerable amount of

data is not normally available from the typical second and third order soil surveys available to us, it is therefore necessary for us to gather it in order to complete our studies. Additionally, economic data relative to yield levels, crop adaptability, costs of production, land development costs, etc., are correlated vith the physical and chemical data to complete the process of predicting payment capacity. This process is

- imilar in many ways to parts of eoil survey interpretive programs, and
- • tudy of it might prove useful in such programs.
- 3. <u>Usefulness of Land Classification Data in Soil Survey Activities</u>
  An can be seen from the above, the process of land classification entails data collection on an intensive basis. Part of the process involves essentially the same procedures used in performance of soil survey; in fact, with little additional effort soil surveys could be accomplished during the land classification process.ely, it weys cappear (in)T848.4677 T788.3

4. Ongoing Soil Survey Interpretive Activities — The Water and Power Resources Service has, for some time, made use of soil surveys in the conduct of land classification studies (as previously mentioned). and continues to do so. This is particularly true of our appraisal level studies, but also holds for some feasibility level studies.

A recent example, which is an interesting case in point, is a modified feasibility level study which is being conducted in the West Sacramento Canals Unit area near Sacramento, California. In this area, many of the lands at present are intensively farmed under irrigation, and have been for many years. Additionally, relatively recent and highly detailed soil surveys have been completed. In this case, we are utilizing the soil survey data to confirm information gathered during land classification studies of a vary low level of detail; and using minimum additional data (such as deep borings, drainage tests, etc.) in areas which are presently under a stable and established irrigated regime. In this way, we are able to concentrate our field efforts in areas which are presently non-irrigated, and in which more detailed information is needed to predict behaviour under irrigation.

Similar procedures are being instituted on a limited basis in Idaho and Washington.

Additional cooperative **efforts** should be encouraged, both for the benefit of our agency, and for the N.C.S.S. cooperating agencies. **We** feel that since **we** have been in the soils interpretive field for a number of years on a very intensive basis, **we** may have a significant contribution co make in this **work**.

# WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE \$01L SURVEY

# Identifying Order 3 and Order 4 Soil Surveys Committee 1

#### Charges

- Expand and Illustrate the criteria for field operation and intensity (kinds of data collection and documentation) which differentiates Order 3 soil surveys from Order 2, and Order 4 from Order 3, including:
  - (a) Re-examine the suitability of soil series level taxa for Order 3 surveys, if Order 3 surveys are to be less intensive investigations.
  - (b) Test phases of soil family taxa to see if they more properly reflect the necessary ranges of properties for taxa mapped at Order 3 or 4 intensity than do series taxa.
  - (c) Establish criteria for keepiny Order 3, and particularly Order 4 soil mapping at <u>low</u> intensity, e.g., record of delineations not entered, or merely traversed.
  - (d) Consider more explicit description and interpretation for contrasting inclusions as a means of generalizing map units without decreasing user confidence.
- Identify the kinds of uses and interpretations to which Order 3 and Order 4 map units can be appropriately applied.
  - (a) Describe the minimum size management units and kinds of management for which Order 3 and Order 4 surveys are sufficient.
  - (b) Describe kinds and sizes of contrasting inclusions which can be tolerated.
  - (c) Investigate new or newly applied phases which would make family level taxa more useful for Order 3 and Order 4 surveys.

### Introduction

This report reflects a revision in charges, committee name and committee emphasis, based on suggestions by Conference Co-chairmen, F. F. Peterson and Douglas Pease.

Present criteria for conduct of Order I and 2 soil Surveys are fairly well accepted. Order 5 surveys are very seldom made or have very special application. Committee members were consequently requested to direct their efforts in relation to the charges, to the study of Order 3 and 4 soil surveys.

Response by committee members indicated that some major problems and disagreement is apparent In the application of existing criteria to differentiate Order 3 soil surveys from Order 2 and Order 4 surveys from Order 3. In nearly every instance the responses indicated problems primarily in application of criteria concerned with kinds of taxonomic units, field procedures, and map scales. Response by several committee members suggested major redefinitions for the Orders of soil Survey. Others indicated disagreements in the interpretation and application of specified field procedures.

Much of the confusion indicated by committee correspondence has apparently resulted from a lack of thorough study and continuing thought about the criteria which presently define Orders of soil survey. In addition there is an Indication that the  $\mathfrak{Lalg}$ 

The National Soils Handbook (USDA-SCSI makes reference to Orders of soil survey only in Part II, Sections 200 and 300. Definitions for the Orders of soil survey are not available in the National Soils Handbook. The revised <u>Soil Survey Manual</u> is expected to contain a discussion of the Orders of soil survey in chapter 2.

Primary committee effort In this report Is devoted to an amplification of the field procedures that differentiate different Orders of soil survey together with a proposal for their application in field operations. The basic concept and structure for the five Orders of soil survey appear to be essentially valid as presently defined, and consequently no major revision is being proposed by this committee.

Specifications for field procedures are the criteria being given special emphasis in this report. They not only differentiate the Orders of soil survey, but also establish the essential basis for quality control and soil correlation. In recognition of these important functions, the chairman for this committee with assistance from Dr. F. F. Peterson has developed the following proposal for conference consideration. The proposal has been designed to resolve some of the confusion and misunderstanding Inherent in present differentiae for soil orders.

## Proposal

# FIELD PROCEDURE SPECIFICATIONS FOR QUALITY CONTROL, CORRELATION. AND DIFFERENTIATION OF ORDER 3 AND ORDER 4 SOIL SURVEYS

Rationale--Order 3 and 4 soil surveys differ from Order 2 surveys in the time spent in validating polypedons. The primary device for lowering field procedure intensity is to validate fewer polypedons by actual examination than for an Order 2 soil survey. This is accomplished by using more soil associations as map units, fewer consociations, and identifying a greater proportion of delineations by observation and photo interpretation than by traversing, and by traversing a much smaller portion of relatively large delineations. Hence, for Order 3 and 4 surveys a very heavy reliance must be placed on transects which establish the genetic relations of component soils to landforms, vegetation, and parent material, etc., for clues for mapping the soil associations.

Since numbers of soil examinations must be reduced--drastically, for Order 4 surveys--one can not assume that most soils of delineations have been validated by examination as one can for the more detailed delineations of Order 2 surveys. For quality control, and for structuring lesser field intensity, a record of the geographic distribution of types of delineation identification procedures should be kept on the field sheets. Geographic distribution of the so critical transects should also be shown, and each transect needs to be explicitly documented.

Soil survey Intensity also may be reduced by using phases of soil families rather than phases of soil series to identify taxonomic units. A series level identification implies numerous validations of both occurrence and property ranges, since series are firmly and traditionally associated with Order 2 surveys. A series-leveltaxonomic unit based on a single pedon chosen to fit a preconceived, or existing concept is both possible and unfortunately probable when series identification is used for Order 3 soil surveys. Phases of soil families and subgroups can be designed to provide necessary information and to extrapolate information. These high level identifications have the advantage of implied generality for soil surveys with less intense validation procedures than Order 2 surveys.

Procedures are proposed to differentiate Order 2, 3, and 4 soil surveys, and to reduce field operation intensity while allowing quality control and assuring any series-level identification will approximate the similar identification in Order 2 surveys.

# Amplified Definitions for Field Procedures

<u>Inasect-</u> (1) The field procedure of crossing delineations or landscape units along selected lines to determine the patterns of polypedons with respect to landforms, geologic formations or other observable features. (2) gridding. (3) Statistical line-transects. 1/

Transects require explicit documentation including:(a) a symbol locating the transect on, and keying the documentation to a field sheet (e.g., "T-73"); (b) a planimetric sketch of the location of the transect within the delineation;(c) a cross-sect ion diagram of the component soils and their associated vegetation or plant community if

known, etc, (d) a pedon description for each component soil; (e) a statement of the landscape-factor related to each soil boundary; and (f) the percentage component composition based on the line transect. This document validates the composition of a map unit and explicitly shows the mapping clues by which additional delineations may be identified.

A sample format which may be used to document transects is attached.

<u>Traverse--Validation</u> of the predicted boundaries or composition of a delineation by entering it, or crossing it, and identifying pedons et selected or random positions.

A traverse requires that the significant horizons of each component soil be examined physically by shovel, auger, or other means. For Order 3 and 4 surveys, the location of the examination should be shown by a symbol (e.g., "10") within the delineation on the field sheet, and keyed to the field notebook, if notes are made. If all components of a map unit are not examined or the site is not located by symbol, the operation shall be considered an "observation."

Observation--Visual checking of landscape features, exposed geological formations, or chance exposures of pedons within or without a delineation to project boundaries and composition from previously determined relations; air photos may be used es guides. This is a less intensive operation than traversing. 1/

Identification by observation requires an on-ground view close enough that individual shrubs, stones, and chance exposures of soil horizons can be seen clearly (i.e., closer than a few hundred yards). Air photo interpretation, or views from aircraft are not "observations." Examples: Observation of fragments of a petrocalcic horizon or a ditchbank exposure of a reddish-brown argillic horizon from a pickup window. Seeing a two-foot-high scarp that is known to separate soils, but is not visible on stereo air photos. Seeing cobbles of limestone on a hillslope that are a diagnostic clue for a particular map unit. Seeing indicator plants or changes in shrub height or density. The sensation of softer, or firmer soil noted when driving across an area, and noting it is related to soil surface color and apparent texture. Seeing salt efflorescences.

Aerial Photo Interpretation--Plotting boundaries and estimating composition of delineations based on air photo features that have been related to soils and landscape features. As the term is used here, air photo interpretation includes applicable remote sensing.

Aerial photo interpretation \( \) a strictly intellectual, second-hand conclusion based on previous correlation features and photo patterns. In comparison, an "observation" is a concrete, novel experience where many more landscape features are apparent than on most photos at scales appropriate to Order 3 and 4 mapping.

# Proposed Field Procedures

generalizing delineation composition (i.e., large-delineation soil association) ordinarily requires some unavoidable incentive. Decreased field sheet scale seems to be the best, since few soil surveyors can refrain from delineating somewhat contrasting soil patterns if they can see them as several-square-centimeter areas on their field sheets. Or, to describe the problem differently, most soil surveyors have been trained with Order 2 surveys, and see Individual landforms, or landform elements, rather than repeating soil patterns of landforms. Both these soil surveyors and later map readers will be bothered by, say, a six-square-inch delineation on a 1:24,000 scale photo base, within which they can see manylandforms. They will however, accept the same delineation on a 1:62,500 scale sheet because it occupies only 0.88 square inches and the visible landforms are only a pattern, rather than "significant" individual areas. Scales appropriate for cartographic specificity or generalization are suggested in Table 1. This guideline does not preclude use of larger or smaller scale. Survey objectives determine the order of survey.

Table 1
GUIDELINES TO FIELD PHOTO-BASE-HAP SCALES
TO FACILITATE VARIOUS ORDERS OF SOIL SURVEY

Soil survey order	Field sheet scale
Order	Larger than 1:10,000
Order 2	1:10,000 to 1:30,000
Order 3	1:30,000 to 1:80,000
Order 4	1:60,000 to 1:125,000
Order 5	N. A.

# Geographic Distribution of Mapping Intensity

Field-Sheet Display-The geographic distribution of any feature can be apprehended only by map display. A party leader needs a display of mapping intensity to guide and control mapping intensity, and a correlation party needs it to exercise quality control. A display of mapping intensity can be had simply, end at no extra effort by merely adding a simple element to the map unit symbol identifying each delineation which indicates the procedure used to identify the soils, and adding small, unobtrusive spot symbols for the approximate sitings of transect and traverse soil examinations. For map unit "173", for example, one could 3dd these letters to Indicate how the component soils of a delineation were identified: (A) by transect; (B) by traverse; (C) by observation; and (D) by air photo Interpretation. A map unit "173-B" then, would mean the delineation should have the "173" soil pattern and composition, and it was confirmed by soil examinations at about the sites Indicated by unobtrusive "10" spot symbols. The use of A, B, C, and D is recommended for use on field sheets as documentation to assist quality control, correlation and other agency activities.

Geographic Happing-Intensity Patterns-Guidelines are needed for geographic distribution of mapping intensity during Order 3 and 4 soil surveys and for their correlation. Since transects define and document map unit composition and mapping concept. transects for any particular map unit need to be spread across its area of occurrence. A minimum number of transects is needed to confirm the definition, but too many will slow the survey. The effort at basic transects probably has to be about the same for all Order 2, 3, and 4 soil surveys; transecting presumes a previous reconnaissance of the survey area and availability of a skeletal legend.

The proportion of delineations of each map unit which are identified by traversing, observation, or air photo interpretation; and the sizes of delineations largely define Order 2, 3, and 4 mapping intensity. Delineation size is best controlled by field sheet scale. Guidelines for intensity of identification procedures are given In Table 2

Table 2
GUIDELINES FOR DELINEATION-IDENTIFICATION PROCEDURE INTENSITY

		Soil survey	order
Mapping Procedure	Order 2	Order 3	Order 4
	1(% of deline	ations of eac	h map unit)
(A) Transecting	15~30	ID- 15	1 - 5
(B) Traversing	50- 65	25-50	IO- 15
(C) Observation	5-15	25-50	40-60
(D) *Air Photo Interpretations	s <b>(</b> 5	IO- 20	20- 30
•	}		

\*Mapping unit boundaries may be predelineated by air photo Interpretation. Percentages indicate delineations not entered for observations, traversing, or transecting.

Soil Boundary Identification-No changes Of additional guidelines are suggested for identifying soil boundaries beyond those contained in the original differentiation of the "Orders of Soil Survey." Boundary identification is basically done by observations and air photo interpretations; with decreasing numbers of traverses and observations, and with larger delineations, more reliance is placed on air photo interpretations.

### Discussion

There was considerable discussion concerned primarily With interpretation of the definitions of field procedures as amplified in the proposal. It was pointed-out that the proposed procedure will not operate satisfactorily without strict adherence to intended conduct of field procedures as defined in this committee report.

# Recommendations

- The Guidelines to Photo-Base-Map Scales to Facilitate Various Orders of Soil Survey
  (Table I) be adopted as guiding criteria in lieu of present map scale guidelines.
- 2. The amplified definitions for field procedures proposed by the committee be approved and strictly adhered-to for use in testing the proposal recommended by the committee.
- 3. The proposed procedures for field-sheet display of mapping Intensity, and Guidelines for Delineation-Identification Procedure Intensity (Table 2) be tested in each of the Western States prior to the 1982 Western Regional Technical Work-Planning Conference for Soil survey.
- 4. The committee be continued for the 1982 conference and the name changed to "Application of Field Procedures for Different Orders of Soil Survey."

The report of the committee with recommendations was approved and accepted by the conference membership.

# References:

I/ Basic definition of mapping operation after the report of ad hoc\_Committee No. 7, Kinds of Soil\_Surveys, Proc.National Soil Survey Conference, January 1975, Orlando, Florida.

# Committee Membership:

Bailey R. Montgomery E. Naphan, Chairman W. Braker G. Nielson T. Cook R. Piper J. Downs R. Fenwick T. Priest E. Richlen M. Fosberg R. Haberman V. Saladen E. Spencer H. Havens G. Madenford J. Young H. Maxwell R. Zimmerman R. Meurisse

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Vegetation:			<del></del>				<del></del> į
Landform:							
Geology:							
Pedon ID's:							Relief
Clues to soil boundaries	-	D:	stance ( )				,

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# WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE FOR COOPERATIVE SOIL SURVEYS SAN DIEGO. CALIFORNIA

February 11-15, 1980

# COMMITTEE 2

Quality Control in 3rd and 4th Order Soil Surveys

# Menbership:

Chairman - R.	Di erki ng	G.	Kennedy
E.	Brown	G.	Logan
J.	Carey	R.	Miles
P.	Derr	A.	Ness
A.	Eri ckson	J.	Rogers
L.	Fletcher	G.	Simonson
L.	Giese	G.	Staid1
R.	Herriman	В.	Thomas
R.	Huff	M	Townsend
G.	<b>Hunti ngton</b>	H.	Waugh
J.	Harman	M	Yee

<u>Charge 1</u> - Explore any Changes needed in requirements of format of work plans (memorandum of understanding).

### Response:

After this charge was given to the committee, National Soil Handbook Section 202, Cooperative Arrangement was distributed. This section includes detailed instructions regarding the preparation of Memoranda of Understanding for soil survey areas. Most of the committee's suggestions for changes are provided for in these new instructions.

The Committee did discuss the need for emphasizing parts of NSH Section 202. For example, some suggested that it should be emphasized that:

- all National Cooperative Soil Survey Areas need memoranda of understanding
- that the memorandum of understanding should be a rather firm committment to make a soil survey of a specified area, initiating and completing the work on specified dates, and definite publication plans
- the SCS is responsible for the correlation of soils
- the agency making the survey is responsible for quality control unless they have an interagency agreement to do otherwise
- that maps used to indicate the survey area should display the ownership pattern, i.e., if the area is land largely federally-owned and administered by the Bureau of Land Management, the map should show the relationship between the federal and nonfederal lands
- the purpose and objectives of the soil survey should identify the principal users and their soil resource information needs so that, if desired, similar statements could be placed in the soil survey

One member of the COmmittee stated there was "too much detailed information and documentation required for the Memorandum of Understanding."

		:

### TABLE OF MINIMUM DOCUMENTATION REQUIREMENTS

### NARRATIVE DESCRIPTIONS FOR DESCRIPTIVE LEGEND

### FIELD NOTES TO SUBSTANIATE DESCRIPTIONS

### DATA

### Mapping **Unit** Components

One complete taxonomic description of each major (areal) soil component with enough data to classify at appropriate categorical level. Includes (a) representative pedon description, (b) range of characteristics of taxon as it occurs in survey area and (c) environmental site data provides enough data for scientific classification. Helpful to know if data for each roil property is assumed, inferred, perceived, or measured.

Nonsoil components require enough data to be defined as nonsoil.

Minor soil components or inclusions need only to be identified.

™ Mapping Unit Composition

Identify the kind(s) of components their composition and pattern of occurrence. Indicate variability of delineations, if significant, for each mapping unit. State if estimated from photo interpretation, traverse or transect.

### INFORMATION

Develop enough information to satisfy users needs. Discuss soil properties or qualities necessary for soil interpretation or soil behavior. Provide enough information to satisfy purpose of survey.

Describe any land use.

Develop information for interpretations only if it affects use or management of major soil components.

Provide enough information so that it is clear the mapping unit is adequate for the purposes of the survey.

Develop plan for taking and filing at the start of survey. For data: Use SCS-232 or similar form for pit or partial excavations. Develop form for auger hole examination.

For Information: Form or outline needs to be developed at the start of each survey

Describe in field notebook.

Describe in field notebook.

If estimated from:

Photo interpretation - describe in field notebook.

Traverse - indicate number and location of delineations traversed.

Describe in field notebook.

Transect - Indicate number and location of delineations transected and provide record of examinations. Describe method used and analysis or evaluations made.

### Field Review Report

Review plans for and progress of soil survey area for both quality and quantity - Past and present work as it relates to the purpose of the soil survey is reviewed

### Review:

- Purpose of soil survey and immediate objectives Decision made to guide the survey and design of mapping units.
- 2. Use of natural resource information in planning survey work and designing mapping units.
- 3. Soil raps for placement of boundaries and legibility of symbols.
- Legend for completeness. Each symbol used on the map is listed in the legend and represents a defined mapping unit or cultural feature.
- 5. Mapping unit definitions for composition and adequacy for the purpose of the survey

- 6. Components of mapping units are scientifically described in order to be properly classified at the appropriate categorical level of Soil Taxonomy. The categorical level used is adequate for providing soil resource information that satisfies the purpose of the soil survey. Nonsoil components have adequate descriptions for recognition.
- 7. The area surveyed and rate of progress.
- 8. Report manuscript preparation and rate of pmgress.

Charge 3 - Consider the kinds and purpose of documentation needed for quality control.

The kinds and purposes of documentation needed for quality control were reviewed by the committee and are Summarized in a table.

### Discussion:

Many of the standards and exhibits for preparing soil and mapping unit descriptions are in Section 300 of the National Soils Handbook. The kinds of and purpose for documentation are also given. The highlights enumerated on the attached table may provide some direction for a meaningful review. In the last analysis, production management, of which quality control is a part, must first make important decisions about the use of men, money, materials and time. Without these decisions, good documentation alone will not provide the quality the users want.

# Recommendation:

- 1. Good examples and guidelines for describing component taxa in the subgroup and family categories. The committee should be continued and develop an example of each.
- 2. The review report from \$CS-233 does not adequately cover the items needed for Order 3 and 4 surveys. The committee recommends that either the form be revised or replaced with a review outline. The committee should be continued and prepare a proposal for the National Soils Handbook.
- 3. Transects are made differently in the western states. The committee recommends that procedures used to transect delineations be documented in Order 3 and 4 soil surveys. The committee should be continued and review the present methods being used and prepare one for adoption and inclusion in the National Soils Handbook.

Charge 4 - Develop a guide for quality control when dealing with private contracts.

# **Response\_:**

Guides for quality control should be the same for all making soil surveys for the National Cooperative Soil Survey. A memorandum of understanding for the survey area should be developed and initiated by the concerned agency prior to any announcement of requests for proposals (RFP). The memo should follow the requirements of Section 200 of the National Soils Handbook and should provide:

- 1. Description and map of area
- 2. Purpose and planned objectives
- 3. Agency or person responsible for quality control
- 5. Time allocated for each phase of the work
- 6. Personnel assigned and responsbilities
- 7. Final product required

Many specific guidelines for quality control occur throughout the National Soils Handbook. Applicable sections should be specifically identified by number or specific guidelines should be developed for the survey area. Attached is (see Appendix) a state supplement to the National Soils Handbook issued by the Nevada SCS state office. This example provides many excellent guidelines.

Many committee members brought up a question that because many contract surveys are made in such a short time, i.e., 2.000.000 acres, 5-month mapping season, and report due 5 months later, can such a survey meet NCSS standards as an Order 3 soil survey? Many of these areas are proposing 50 to 75 percent new soil series, mapped at a scale of 1:24,000 with 10 acre minimum delineations. Possibly these kinds of surveys need different guidelines and called something other than a National Cooperative Soil Survey.

All NCSS's require they be correlated as they progress and that the correlation be kept current. All contract or interagency surveys in order to meet NCSS standards should have a field correlation when the designated area is finished and a certified field correlation memorandum prepared by the SCS state soil scientist.

# Recommendation:

That any guide for quality control that is developed be the same for all who make soil surveys. That the suggestions in charge 3 be used as a framework for developing a guide. If recommendations in charge 3 are completed, they also could be incorporated in the guide. The committee be continued to complete charge 4.

# GUIDELINES FOR QUALITY CONTROL FOR SOIL SURVEYS IN NEVADA

# I. Presurvey Guidelines

- A. Skeletal identification legend: to be developed if prior mapping has been completed in adjacent areas.
- B. State classification of Nevada soil series: Soil Classification, Soils of Nevada, (as revised). USDA-SCS, Rena, Nevada.
  - C. Official Nevada soil series descriptions (definitions).
  - D. Cartographic legend (conventional and special symbols) SCS-SOILS-37A.
  - E. Complete set of range site descriptions for resource area.
  - F. Matching adjacent soil maps is required if prior mapping completed.
- 6. Airphoto field sheets: Orthaphotos if available or other suitable airphotos at a scale of 1:24,000.
- H. Instructions for archaelogical clearance and other restrictions: follow guidelines developed by other state or federal agencies when survey is on lands under their control.
- $I. \quad \textbf{Schedules of initial, progress, and final field reviews: to be developed by the Nevada State Office.}$
- J. Initial assistance for legend development and orientation in the area as needed: soil survey assistance to be provided by the State Office.
- K. Plan to complete salt profile determinations ( $ECx10^3$  mmhos/cm) for key soils in subgroups of Aridisols, Entisols, Mollisols, Inceptisols, and Vertisols as needed to support soil classification, soil mapping and soil interpretations.
- L. Plan to maintain systematic complete, legible field notes on map unit characteristics, composition, interpretations, and field pedon descriptions.
- M Plan to acquaint party members with the plant ecology, geology, climate, and geomorphology of the area.
- N. Utilize the availability of assistance as needed from soil specialists to assist on difficult problems concerned with design of map units, soil classification, soil interpretations, and procedures to determine composition of soil map unit.
- II. Instructions for Compliance with National Cooperative Soil Survey Standards
- A. Identification legend: a list of map unit symbols and names of map units as provided for in Section 302.7(b). The identification legend will be prepared in the following format.
- 1 .Map unit symbol: 3-digit number. The first two digits of the symbol will designate the soil series; the third digit the phase of the soil series. Symbols for soil associations and complexes will utilize the designation for the first named component of the map unit. Map unit numbers including designations for land types will be developed by the party leader.

- 2. Each map unit on the identification legend will have a listing below the name of the following:
- (a) Full name of each major component and proportion when the map unit is an association or complex.
  - (b) Names of each contrasting inclusion and its proportion.
- (c) The range site designation for each major component soil and contrasting inclusion.

Example identification legend listing:

Gamma gravelly sandy loam, 15 to 30 percent slopes (90%);
Range site NV-28-90, Upland loam, 8 to IO-inch
precipitation zone.

Included soils and/or land types:
 Sigma loam 8 to 15 percent slopes (5%); Range site
 NV-28-88, Semiwet meadow,

Rubble land (5%).

118 Gamma-Sigma-Beta association

Gamma gravelly sandy loam, 15 to 30 percent slopes (50%); Range site NV-26-90, Upland loam, 8 to IO-inch precipitation zone.

Sigma loam, 8 to 15 percent slopes (25%); Range site NV-28-88, Semiwest meadow.

Beta cobbly loam, 8 to 15 percent slopes (15%); Range site NV-28-85, Claypan, 8 to lo-inch precipitation zone.

Inculded soils and/or land types: Clayey and loamy-skeletal Aquolis, 4 to 8 percent slopes (10%); Range site NV-28-87, Wet meadow.

Rubble land (5%).

- B. Soil taxons and/or land types to be used in map units.
  - 1. Phases of soil series as listed in Section 302.7(b)(3)(i)-(vi).
  - 2. Miscellaneous land types only those listed and defined in Section 301.5(g).
- 3. Phases of taxons in higher categories of <u>Soil Taxonomy</u> may be used only where variability or extreme detailed complexity preclude practical designation of a soil series for use in mapping.
- 4. Variants for use to designate soils of a previously unrecognized soil series, but having insufficient area to be proposed for series status (i.e., less than 2,000 acres).
  - Contrasting included soils and/or land types.
- Contrasting included components of map units are to be identified and listed in each map unit.
- 2. The total amount of contrasting included soils and/or land types in a map unit is limited to 15 percent, except in special cases approved by the SCS Soils Specialist.

- D. Noncontrasting included soils and/or land types.
- 1. Similar soils and taxadjuncts that are mapped with major soils will be noted in the last paragraph of the map unit description.
  - E. Special Symbols used to identify contrasting soils and/or land types.
- 1. Areas of contrasting soils and/or land types that are less than the minimum size delineation may be designated by special spot symbols if they do not consistently occur within each delineation of a map unit and consequently cannot be considered as inclusions in map units. This is provided for in Section 302.7(c)(3).
- 2. The equivalent acres designated by each spot symbol will be listed in the identification and cartographic legends. Section 302.7(c)(3)(ii).
  - F. Design of map units.
- 1. Map units may be consociations, associations, or complexes of named soil taxons and/or land types.
- $\,$  2. Components of map units will not exceed three named major soils and/or land types plus the contrasting inclusions.
- 3. Each map unit will be valid in relation to delineation, component soils and/or land types and definition to assure that the objectives of the soil survey are adequately satisfied. General guidelines set forth in Section 302.6.
  - G. Conventional and special symbols used on field sheets.
- 1. Conventional and special symbols used on field sheets will be those listed on Exhibit 302.7(c)(1) SCS-SOILS-37A. The specific symbols to be used will be underlined on the SCS-SOILS-37A and agreed-to during the initial field review and further reviewed and modified as needed during subsequent field reviews. Guidelines set forth in Section 302.7(c).
  - H. Matching with prior completed soil surveys.
- 1. Areas mapped within the survey area will be matched with prior completed soil surveys. Deviations from satisfactory matching will be explained by the SCS Soils Specialist in reports of reviews.
  - I. Table of soil classification.
- 1. The placement of each soil series or other taxon in the SOIF laxonomy will be maintained in a table of soil classification as set forth in Sect 302.7(a)(1)(iiij). The status of each taxon listed on this table will be indicated according to the designations used in "Soil Classification, Soils of Nevada," (as revised). USDA-SCS, Reno, Nevada.
- III. Soil Descriptions.
- A. Soil Map unit descriptions for each map unit will be prepared as required by Section 302.7(a)(1)(i).
- B. Soil pedon descriptions typifying each taxon mapped in the area will be preapred as required by Section 302.7(a)(1)(ii).

# IV. Soil samples.

A. Pedons of soil taxons mapped in the area will be recommended for sampling and laboratory analysis as set for in Section 303.5. Soil sampling will not proceed, however, without Nevada State Office approval which will be based on need for soil classification, interpretations and other needs.

B. Soil correlation samples for each horizon of the typifying pedon for soil taxons mapped in the area will be collected and supplied by the party leader as set forth in Section 301.4(b)(2)(y)(B).

# V. Soil mapping.

A. The party leader will conduct field mapping by progressive block mapping to assure consistency between party members, and adequate control of the soil mapping legend.

# VI. Field Reviews.

- A. The State Soil Scientist or designated representative will conduct initial, progress and final reviews as specified under Section 303.2(a) and (b).
  - B. The party leader will have available at each review.
    - 1. Field sheets.
    - 2. Identification legend.
    - 3. Soil map unit descriptions.
    - 4. Soil pedon descriptions,
    - 5. Soil interpretations.
- 6. Sites available for typifying proposals for new soil series, and other sites where problems in soil classification, mapping, and interpretation have been encountered.
  - 7. Sites for pedons proposed for laboratory studies.
  - 8. Field notes pertaining to pedon and map unit descriptions.
- C. Informal assistance will be provided as needed to the soil survey party during progress of the soil survey by SCS soil specialists, range conservationists and other specialists. Records of such assistance including decisions agreed-to, and instructions provided will be documented by memorandum to the State Conservationist with copies to the district conservationist, party leader and others as necessary.
- VII. Appraisal of the quality of the soil survey.
- A. Representatives of SCS Nevada State Office will appraise the quality of the soil survey during field reviews in relation to its intended purpose and function as set forth in the National Soils Handbook. Deficiencies and actions agreed-upon to resolve deficiencies will be recorded in memorandums or reports of field reviews whichever is applicable.
- β. The validity of soil map unit delineations in relation to the soil map unit descriptions, which have been prepared by the survey party will be verified by transect on a selected percentage of the soil map units listed in the identification legend. Soil map units which will be verified in this procedure will be selected by the Soil Specialist. The result of verification studies will be used to evaluate the quality of the soil survey, and documented in reports of field reviews together with any actions agreed-to with the party leader to restore serious deficiencies. Additional guidelines are in Section 303.6(a).

# VIII. Field correlation.

A. Guidelines set forth in Section 301.4 and 303.6(b).

# WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY

# SOIL SURVEY MANUSCRIPT FORMAT(S) COMMITTEE 3

The original charges for this committee were:

- 1. Develop manuscript format(s) that will meet the needs of users where land is under one agency control.
- 2. Explore the requirements for map scale and legends.
- 3. Develop ideas on how to present soil interpretations.
- 4. Evaluate phase naming conventions for soil families.

These charges were reduced to the following two:

- 1. Develop a manuscript format(s) that meet the needs of users where the land is under one agency control.
- 2. Evaluate phase naming conventions for taxonomic units other than soil series.

Review and Summary of Charges:

# Charge 1

Several committee members expressed the opinion that they felt this subject had been adequately dealt with by a previous Committee (Committee 1, February g-13, 1971, Phoenix, Arizona). There exists concern among most members that user needs be paramount in selection of a report format. A recent draft has been circulated on alternatives for publication of soil survey in areas where there are only a few landowners, or where Federal Cooperating Agencies are the principal landowners. Minimum standards for content will affect the report format.

Appendix D to H in the proceeding for the Phoenix 1976 meeting contains format examples that could be used as guides to published soil survey. Recent examples are included with this Committee report.

The suggested formats would circumvent total dependence on the computer assisted writing (CAW) approach. Sections of the report would still be dependent on the CAW program Tables would replace traditional map unit write-ups, contain ranges in soil and map unit properties, and relevant interpretations.

Several members were concerned about the type of information or data needed to fulfill a mission. It was expressed that the users' "need" for information should be considered when selecting the party leader, order of survey, field procedures, etc., as well as the final report format.

# Recommendations:

- 1. Report format should be optional but specified in the Memorandum of Understanding for the survey area.
- 2. The use of the modular writing format for all orders of soil survey is negotiable. The tabular format offers an alternative.
- 3. The content of the report should be flexible but must meet the minimum standards of the National Cooperative Soil Survey. The report must meet the needs of intended users.
- 4. The optional format should be available, regardless of ownership.

# **E**harge

# Probl em

The use of soil family class names is often felt to be awkward and cumbersome when used as components in the names of mapping units. There is a limited amount of space for these names on Forms (5 and 6).

Examples are included that deal with approaches for solving part of this problem The Committee remains divided on the best conventions for handling this problem

# Recommendations..

1. Conventions for naming map units when the family or higher taxa is used as the reference taxon is an option of the agency implementing the survey but should be compatible with the National Soils Handbook.

The conference recommended that this committee be discontinued,

# UNITED STATES DEPARTMENT OF AGRICULTURE

**501.** CONSERVATION SERVICE

West Technical Service Center, 511 N.W Broadway: Rm. 510. Portland, OR 97209

SUBJECT SC - Soil Correlation - Names for Map Units

DAIL Hay 23. 1979

Richard W. Ferwick, State Soil Scientist SCS, Davis, California

Charles Goudey, Forest Service San Francisco, California

I have discussed with my staff end Washington conventions for naming map units when the family or higher taxa is used as the reference taxon. The family taxon is by a long ways the most difficult one to use. Following are the guidelines to follow:

# Family name used as reference taxon

There are two alternatives:

- 1. Use the technical family name with one or more descriptive terms.
- 2. Use short name for family (series name) followed by the word "Family" and one or more descriptive terms.

If class in category above the family is the reference taxon, use class name, followed by one or more descriptive terms

Examples: Udolls, shallow

Haplargids, steep

# Miscellaneous areas

Name of kind of miscellaneous area stands alone unless modifying term is needed. Any modifying name follows name of area.

**Examples:** Rock outcrop

Rock outcrop, basalt



# **Associations and Complexes**

Names of two or three taxa are used as reference terms unless are taxon dominates and the other components are of minor extent. Follow with words "complex" or "association" and any additional modifying terms that may be needed.

# Examples:

1. Fine-loamy. mixed, mesic Typic Haplargic ic Haplargi. þøÿð> Hap 680. 1600378 204. 4

# CLASSIFICATION AND CORRELATION OF THE SOILS OF THE

GRANT COUNTY, NEW MEXICO CENTRAL AND SOUTHERN PARTS

JULY 1979

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OIL	CONSERV	VATION	SERVIC	CE,	USDA
WFS	T TECHN	ICAL SE	RVICE	CFI	NTFR

PORTLAND, OREGON

FOR IN-SERVICE USE ONLY

SOIL & WATER

LARSON SCHMIDT	
Stury	
Solomon	
CARLETON	<i></i>
Taylor	<u> </u>
Walker	
Brown	
THOMPSON	
<b>NARTINEZ</b>	<u> </u>
Sicilists.	<del></del>

NOV 2 8 1979

# Portion Surveyed by Forest Service

# Burro Mt. Land Management Planning Area

Field Symbol	_ Field Name	Approved Name	Publication Symbol
324	Aridic Haplustalfs. fine, mixed, mesic - lypic Ustorthents, loamy-skeletal, mixed, nonacid, mesic association, 15 to 40 percent slopes	Same as field	name 74
325	Aridic Haplustalfs - Typic Ustorthents association, 40 to 80 percent slopes	Same as field	name 75
1	Cumulic Haplustolls - Aridic Haplustalfs complex, 1 to15 percent slopes	Same as field	name 76
311	Lithic Haploborolls, loamy, mixed, warm 1 to 15 percent slopes	Same as field	name 77
312	Lithic Haploborolls. loamy, mixed. warm 15 to 40 percent slopes	Same as field	name 78
313	Lithic Haploborolls. warm, 40 to 80 percent slope5	Same as field	name 79
315	Lithic Haplustalfs, dry - Aridic Haplustalfs complex. 15 to 40 percent slopes	Same as field	name 80
316	Lithic Haplustalfs, dry • Aridic Haplustalfs complex, 40 to 80 percent slope5	Same as field	name 81
327	Lithic Haolustalfs. drv - Lithic Ustorthents. moist association, 40 to 80 percent slope:.	Same as field	name 82
309, 318	Lithic Haplustalfs, loamy-skeletal, mixed, mesic - Lithic Haplustolls, loamy-skeletal. mixed, mesic complex, moist, 15 to 40 percent slopes	Same as field	name 83
3 0 7	Lithic Haplustolls, loamy-skeletal, mixed, mesic - Typic Haplustalfs, fine, mixed, mesic complex, 40 to 80 percent slopes	Same as field	name 84
310, 319	Lithic Ustorthents. loamy-skeletal, mixed, nonacid, mesic - Typic Ustorthents, loamy-skeletal, mixed, nonacid, mesic complex, moist, 40 to 80 percent slopes	Same as field	name 85
101	Rock Outcrop - Ustorthents - Haplustolls complex, 25 to 100 percent slopes	Same as field	name 86

# Portion Surveyed by Forest Service'

# Burro Mt. Land Management Planning Area

Field				<b>Publication</b>
Symbol 1	Field Name	Approved	Name	S <i>y</i> mbol
303	Typic Haplustalfs. flne, mixed, mesic • Lithic Haplustolls, loamy-skeletal, mixed, mesic complex, 1 to 15 percent slopes	Same as	field	name 87
306	Typic Haplustalfs, fine, mixed, mesic - Lithic Haplustolls, loamy-skeletal, mixed, mesic complex, 15 to 40 percent slopes	Same as	field	name 88
25	Typic Ustipsamments, mixed, mesic - Cumulic Haplustolls, coarse-loamy, mixed, mesic complex, 1 to 10 percent slopes	Same as	field	name 89
308, 317	Udic Ustochrepts. coarse-loamy, mixed, mesic • Lithic Haplustalfs, loamy-skeletal, mixed. mesic. moist complex, 1 to 15 percent slopes	Same as	field	name 90

# Notes to Accompany the Classification and C&elation of the Solis of Grant County. New Mexico, Central and Southern Parts

by

# J. Ellsworth Brown

- 1. Abrazo Series. Subsequent to the final field review but prior to the final correlation a decision was made to propose the Abrazo series for the soil formerly named Sotella in the legend. The Sotella series is tentative and was proposed in an area not presently being surveyed. Also, its concept is rather uncertain.
- 2. Bucklebar Series. Mapping unit 87 consists of 325 areas and is adjacent to mapping unit 301 which consists of 91,222 acres. Since Bucklebar is also the largest component of mapping unit 301, nothing is gained by keeping these mapping units apart, Mapping unit 87 is combined with mapping unit 301.
- 3. <u>Encierro Series.</u> The soils of mapping units 441 and 57 were named Daze in the field correlation. However, further testing revealed that the soils are within the ranges of the established Encierro series. There is some difference in the nature of the underlying rock but this is not considered to be a series criterion.
- 4. <u>Haverson Series.</u> The soils of mapping unit 18 were named San Mate; in the field correlation. These soils are within the range of the Haverson series which has been more widely used and has been used in several recent correlations. The San Mateo series will be placed on the inactive lfst.
- 5. Jonale Series. The name of the Lashun series was changed to Jonale after the final field review, to avoid conflict with the established Lassen series.
- 6. Sanloren-Majada Variant complex. The Majada softs in this mapping unit are a variant to the series because they are noncalcareous throughout. The soils of the Majada series have B3ca and Cca horizons.
- 7. Santa Fe, dry-Rock outcrop complex. The Santa Fe soils of mapping unit 403 are somewhat drier than the Santa Fe soils in mapping unit 46. This is supported by a change in vegetation--grass on mapping unit 403 and mixed grass and pinyon-juniper on mapping unit 46. The phase is needed for management and use interpretations.
- 8. Stirk Variant. The Stirk Variant sofls have mean annual soil temperature of about  $57^{\circ}$  to  $56^{\circ}$  F. Judgfng from the stated air temperatures, the Stirk series of South Dakota has mean annual soil temperatures of about  $47^{\circ}$  to  $51^{\circ}$  F. Also, the Stirk Variant is fine rather than very-fine in the particle-size control section. The acreage of the variant is 846 acres. The decision to use a varfant of the Stirk series was made after the final field review and prior to the final correlation.

- 9. Moist and Dry Phases. Units 308, 309, 310. 315, 316 and 327 in the Forest Service portion contain moist or dry phases. These phases have been used to range the soils from the central concept of the ustic-mesic range. Moist phases are wetter and have different potential vegetation and production potentials than their Typic and Aridic counterparts. Lithic Haplustalfs, moist are associated with Udic Haplustalfs. Lithic Haplustalfs without moisture phases are associated with Typic Haplustalfs. Lithic Haplustalfs, dry are associated with Aridic Haplustalfs. Typic Ustorthents, moist occupy the slot that the proposed Udic Ustorthents would have held If they had been recognized in Soil Taxonomy.
- 10. <u>Warm Phases.</u> Mapping units 311, 312 and 313 of the Forest Service portion are designated as warm phases of Lithic Haploborolls. The soil temperature is  $44^{\circ}$  to  $46^{\circ}$  F. Potential vegetation is ponderosa pine-alligator juniper. The typical Lithic Hoploborolls have potential vegetation of ponderosa pine and the production potential for ponderosa pine is considerably higher.
- 11. It is recognized that certain differences exist between the Soil Conservation Service and Forest Service as to the objectives of soil surveys, mapping procedures, design of mapping units and conventions for publication. There are also differences in the application of Soil Taxonomy, specifically in separating between Aridisols and Alfisols. These differences are not resolved at the time of this final correlation. They are not obvious because of the different kinds of mapping units, but the differences are there. The ongoing moisture and temperature studies in New Mexico should help to resolve the problem Changes may be needed in the definition of the moisture control section as well as in the application of soil taxonomy.

# SOIL-VEGETATIO(J-CLIMATE RELATIONSHIPS L..WCQLN.NATIONAL FOREST

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# SOIL - VEGETATION - CLIMATE RELATIONSHIPS

# LINCOLN NATIONAL FOREST PLANT SPECIES LIST

COMMON NAME	SCIENTIFIC NAME	COMMON NAME	\$
ligator Juniper	Juniperus deppeana	Pinyon Pine	F
Arizona Fescue	Festuca ● rizonica	Ponderosa Pine	E
Aspen	Populus tremuloides	Sand Dropseed	
Black Grama	Bouteloua eriopoda	Sideoats Grama	I
Blue Grama	Bouteloua gracilis	Skunkbush Sumac	I
Bush Muhly	Muhlenbergia porteri	Snowberry	£
Corkbark Fir	Abies arizonica	Sotol	ι
Cresote bush	Larres tridentata	Southwestern	1
Douglas-fir	Pseudotsuga menziesii	White Pine	
Engelmann Spruce	Pices engelmannii	Spike Dropseed	
Galleta			
Gambel Oak			
Gray Oak			
Hairy Hountain Mahogany			
Kentucky Bluegrass			
: Lechuguilla			•
Little Bluestem			
Littleleaf Sumac			
Mountain Brome			
Mountain Muhly			
New Mexico			
Feathergrass			
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# Charge 1 Recommendations:

- 1. Each soil survey party should have constant access to truck mounted backhoes. Four wheel drive trucks with backhoes would be more useful.
- Suggust that states consider, on a trial basis, motor cycles for soil survey areas.
- 3. When economically feasible, an airplane or helicopter should be used in soil survey.
- 4. Each soil survey area should obtain and use landsat imagery.
- 5. The results of the current FS. SCS, and BLM remote sensing study should be reviewed for future application.

# Charge 2 Discussion:

Plant scientists and soil scientists generally work as a team in order to determine the map units used in a range land or forest soil survey. Soil scientists usually lack formal training in plant identification but have often gained on-the-job training. In many instances, the only mention of the plant community by soil scientists is a brief list of the major plants on SCS-232s or related forms. Generally, soil-plant relationships are not documented because the process is time consuming.' There is not a uniform interest, therefore documentation is not uniform. Recently, there has been much pressure to rapidly survey large areas often at the sacrifice of documentation. Map units are often changed to fit range site concepts by phasing. The range site concept is not uniformly applied or accepted. Soil-vegetation relationships are rarely considered except to make sure range site-soil phase boundaries match. The facts are often stretched to make the concept work.

Vegetation data has been collected in numerous areas by recording actual annual yield measured by clipping studies. These data are then extrapolated to similar environments. Guidelines, however, as to what constitutes a similar environment are generally lacking. Often climate is considered to be the environment.

The climax vegetation of an area is a reflection of the moisture regime (Daubenmire, 1968b). This idea is the basis for using plant communities to infer soil moisture regimes in the field. Soil moisture is often the major soil change. Soil moisture, however, is not the only factor that is important in defining the range of a plant community. The area occupied by a plant community is also limited by the component plant-species tolerance of a number of environmental parameters. This tolerance varies from plant to plant and has been referred to as the ecological amplitude of a plant (Daubenmire, 1968a).

Plants appear to have a capability to integrate the **soil moisture** and temperature facets to a greater degree of refinement than we are currently doing with gross measurements. Other environmental factors to consider in extrapolation are: permafrost, length of day, drainage, winds, air drainage, salinity, depth to rock, available water, aspect, **prevalance** of fire, grazing intensity, numerous **microclimatic** factors, etc.

Some plants can be associated very closely with such things as acid or alkaline conditions of soils, and their **growth** within **pH** margins are quite restrictive. However, there are **other** plants that will identify in one geographical setting with specific conditions, with hardly any other vegetation identifying with **that** or those conditions, but that same plant may show up in other geographical settings with different soil conditions; maybe with a different leaf size or stern color.

The vegetation and changes in plant communities are one of the first observations made by a soils man. These provide important clues on possible soil types, soil boundaries, etc. In most situations, vegetation can be used as an indicator in mapping soils. This will vary according to vegetative species, nature of the land, climate, etc. Just because vegetation can be used as an indicator, it cannot take the place of a thorough soil examination. Vegetation should be used only as an indicator. Map units may need to be divided further using other criteria, but vegetation breaks should be used as a key. Several unpublished soil survey investigation projects support this. In the northern Black Hills, Ponderosa pine is the dominant vegetation on frigid soils. Whereas, Black . Hills spruce is dominant on the cryic soils. In the transition zone between cryic and frigid soil temperature regimes, soil temperatures are largely a function of slope and aspect. Steeper slopes and northerly aspects in this zone are mostly responsible for the colder soils.

In Teton Co., Wyoming, the Tine and Tineman soils are mapped accurately by kind of vegetation. The Tine series is covered by low sagebrush and grass and the Tineman soils by big sagebrush and grass. The explanation for the difference in the vegetation is in the available water content of the two soils, which is largely a result of the thickness of loamy sediment over the sandy-skeletal outwash.

The Donna-Stampede and the Stampede-Donna map units in northern Nevada are mapped and described accurately by the use of kind of vegetation also. Donna is an Abruptic Aridic Durixeroll, very fine, montmorillonitic, frigid family, whereas stampede is an Aridic Durixeroll, fine, montmorillonitic, frigid family. Donna supports low sagebrush, Stampede big sagebrush. The difference in kind of vegetation apparently is the result of differences in available water in the two soils. Depth of rooting in horizon thicknesses of the two soils follows this difference also. In burned over areas A horizon thickness is the best way to identify the two soils to determine the composition of the map unit.

A recent paper by Munn, Nielsen, and Muggler (1978) deals with soil-veg relationships. They did not find a perfect relationship between habitat types and taxonomic units, but they did find the kinds of soils which are associated habitat types. They found that total range production correlates well with thickness of the mollic epipedon. They found that thickness of the mollic epipedon was more important to range production than such other variables as total organic matter, thickness of A horizon, and depth to calcium carbonate.

Soil-plant relationships are often determined by transecting representative landscapes. Examples of soil-veg relationships are shown in attachment 1 and 2. Attachment 2 is very useful in showing relationships but they must be supported by data.

Cluster analysis has been successfully used in Utah to relate soil parameters to vegetation.

The factors of soil formation limit the distribution of soil series and map units. Climate and vegetation are not similar over wide areas. Many soil scientists have used MLRAs as the restricting limit on the distribution of a soil. These should be only used as a quide in identifying the general nature of the land and vegetation. Map units must accurately reflect soil identification. MLRA boundaries are very general and often ill defined. Class limits of soil parameters do not always correspond to these general MLRA boundaries. Range conservationists are often insistant on soil series or map unit restriction to a single MLRA. We generally do not have an adequeate knowledge of soil parameters and the relationship to vegetation to interpret the maps in the detail desired. We need to approach detailed studies of environmental parameters causing soil formation.

# Charge 2 Recommendations:

- 1. Vegetation-soil relationships should be documented over the entire soil survey area.
- 2. The vegetation should be reported for the entire range of a map unit and soil series. Range and standard deviation may be useful.
- 3. MLRAs should not restrict map units.

# Charge 3 Discussion:

Plant and soil scientist generally **work** as a team to select sites representative of the community and associated soils (discussed under charge 2). In the xeric, **ustic** and **aridic** moisture regimes where moisture stress is rather critical at sometime we still find it difficult to relate some plant communities to observable soil features. Consequently we wind up with phrases such as high rainfall, low rainfall, extended season, limited season, etc. The soil moisture regimes in taxonomy are defined to a considerable extent on inferred rather than measured moisture and temperature data. If we are going to improve our understanding of **soil-veg** correlation, we must refine our moisture and temperature regimes to permit more specific definition.

Very little work has been done in comparing soil moisture regimes, as defined in Soil Taxonomy. Criteria for separating soils with xeric and udic moisture regimes in the coastal range mountains of Oregon have indicated that the same plant species growing in different climatic zones within a local geographical area respond differently to water stresses (Thomas et al., 1973). authors tried to correlate plant water suction with soil classification criteria. In another study, the soils on an area that had previously been classified were compared in a attempt to find an alternative method of defining the soil moisture regimes (Nichols and Stone, 1970). The soils were in the typic and udic subgroup of the ustic soil moisture regime in an area where the annual precipitation varied from 450 to 800 mm. Soil moisture was measured with the neutron probe using two access tubes per plot. The soil moisture for various depth intervals was compared to the annual precipitation on the plots. The days when the depth intervals were dry in some part were hightly correlated with the annual precipitation. This study did not attempt to calculate the soil moisture control section or determine the number of days the SMCS was dry or moist throughout. These data are needed to accurately classify the soil moisture regime.

A more recent study of soil moisture regimes, as defined in <u>Soil Taxonomy</u>, was conducted in New Mexico on soils in the **aridic** soil moisture regime (Herbel and **Gile**, 1973). Soil moisture was monitored at various depths throughout a lo-year period. Not all measured soil moisture regimes agreed with the previous classification of the sites. Attachment 3 summarizes a recent study by Zobeck (1980).

No studies could be found to describe the use of the definition of the soil moisture control section, es described in <u>Soil Taxonomy</u>, by direct measurement in the field. Nichols and Stone (1970) estimated the soil moisture control section between 10 and 30 cm on the basis of profile texture. They did not attempt to estimate the soil **maisture** control section by using hydraulic properties easily obtainable from laboratory data.

The best method to measure the SMCS would be a field method. In this method, the depth to which 2.5 and 7.5 cm of water penetrate into a field dry soil indicates the depth interval for the SMCS. The depth of moisture penetration is found by observing where the wetting front stops, indicated by a color change in the soil profile. The penetration of the 2.5 cm of water after one day is the upper boundary of the SMCS. The lower boundary is found in a similar fashion, using 7.5 cm of water and observing the wetting front after two days.

Soils are rarely dry enough to directly **measure** the SMCS. In view of this problem, the **SMCSs** can be calculated using laboratory data. The amount of water in a soil is equal to the **amount** of water per unit-depth times the depth over which the water is measured. Similarly, the amount of en added volume of water to a soil is equal to the difference between the final and initial moisture content of a soil (on a volume basis) times the depth of penetration. This relationship is described by the equation:

Volume added (cm) • (Final moisture content (cm/cm)-Initial moisture content (cm/cm))x Depth (cm)

The depth of penetration of a specific volume of water added to the soil can be found by the following equation:

Depth penetrated (cm) Volume added (cm)

(Final moisture content (cm/cm) Initial moisture content (cm/cm))

The initial moisture content is that found at 15-bars tension. The final moisture content is the moisture et 1/3 bar, as determined by a pressure-plate apparatus. The computer model described in attachment 3 agrees closely with the choice of 1/3 bar water as the final moisture content. The moisture contents on a mass basis are converted to the volume basis by multiplying by the buik density of the horizon in question. The SMCS for each method is found by applying the equation to each horizon. The upper boundary of the SMCS is found by using 2.5 cm for the volume-added value. The lower boundary is found by using 7.5 cm for the volume-added figure.

Consideration has been given to changing the moisture control section. There is a strong agronomic bias in the current definition. There are different kinds of plants which compete for soil moisture et different depths. In the desert there are some which compete best for water at shallow soil depths, some which compete best for water in the soil moisture control section, and others which extract water from depths much below the SMCS. In a true desert at least, there does not seem to be any advantage to changing the definition for the SMCS.

Annuals, deciduous perennials, and succulents in deserts utilize soil water from shallow depths. These drought escaping plants compete for soil water when soil water tensions are low. They grow in areas which seldom receive an inch of water at a time, hence their roots may not even reach the soil moisture control section. The proportion of annuals in the flora of deserts increases as the annual precipitation decreases and year-to-year amounts of precipitation become more variable. Deciduous perennials dominate in deserts having predictable wet seasons. The succulents have the lowest growth rates but the highest water use efficiencies of the three types of desert plants feeding on soil water at shallow depths. The succulents, therefore, predominate on the coarse soils and on rocky slopes.

Deep-rooted phreatophytes tap water sources at great soil depths, sometimes more than 10 m. The soil moisture control section will not include the soil depths generally used by these plents. Some mesquite trees have been known to have roots as deep as 80 m. Mesquite trees survive on the less dependable underground water supplies and are considered fairly xerophytic. Poplar trees utilize a more dependable underground water supply and are more mesophytic phreatnphytes. The underground water may have accumulated from extensive areas of soils with desert pavements or from shallow soils over rock or pans.

Drought enduring evergreen shrubs have root systems which come closer to the depths included in the soil moisture control section. The creosotebush is one of these plants. It has been able to maintain growth under soil water potentials of less than -50 bars. These plants compete well on the finer textured soils and flats. Sagebrush competes best where precipitation is somewhat higher and soil textures are loamy. Some Atreplex species have an osmotic potential of -30 bars. What is dry?

The SMCS can be directly monitored in order to determine the moisture regime, but that is time consuming. Several alternate methods have been used. A slightly modifed Thornthwaite technique (Zobeck, 1980) of calculating water budgets (Thornthwaite and Mather, 1955) has been used. This method utilizes the evapotranspiration, as predicted by Thornthwaite (1948), the water-holding capacity of the soil, and the measured precipitation to determine the moisture status of the soil throughout the year. The water-holding capacity is calculated as the amount of water held between 1/3 and 15-bars tension to the lower boundary of the SMCS. The difference between the precipitation and the evapotranspiration is added to the amount of water in the profile for each month. It is assumed that each SMCS is initially moist when the soil temperature at 50 cm reaches **5C** in the spring and no runoff occurs. The period of time during which the SMCS is dry, dry in some part, or moist for each appropriate soil is calculated. As in the other methods, the soil moisture regimes are calculated for periods when the soil temperature at a depth of 50 cm wa equal to or greater than 5C.

The Newhall model of the Soil Conservation Service has been used in many area. In this method, moisture distributions are predicted by assuming the potential evapotranspiration is uniformly distributed over all the days of the month, and moisture removal is proportional to available water/available water capacity (Newhall, 1976). Rainfall is distributed by assuming ½ of the mean monthly precipitation falls in one storm at the middle of the month, and the rest falls as light showers throughout the remainder of the month. The available water capacity is used to estimate the SMCS. Moisture regimes are calculated for periods when the soil temperature at 50 cm reaches 5C.

When soil moisture control sections are monitered to determine the moisture regime, a gravitational technique is often used. In Johnson Co., Wyoming, the NSSL in Lincoln worked out a study on 15-bar moisture to see if an experienced field man could estimate whether the samples in the field were above or below 15-bar. This worked real well except in frozen soil, and when the fingers are too cold to get a good "feel" of soil moisture. Another angle is to have the lab calibrate some samples, from the same sites, at a certain moisture %, and have the field man "se these as a guide. This works very well for a limited time, until the samples change moisture % thru opening the containers several times.

Nelson's (1975) estimation of 15-bar percentage by desorption of soil on hectorite clay is useful and is a quasi-field procedure that could be used to determine when the soil is dry. Fifteen-bar percentage is estimated after desorption of a wet soil by hectorite for a specified time that varies with the amount of organic matter, clay, and pyroclastics and with the dominant mineral in the soil. The determination can be completed within 26 to 36 hours.

When instrumentation is selected for monitoring moisture, the full range of moisture should be considered. The following is a summary of available instruments as listed in Soil Note No. 7. A tensiometer measures matric potential (bars)in the range of about 0.8 to 0.0 bars. It is reliable, simple and inexpensive but has a limited moisture range. Periodic servicing is required. It is subject to damage by animals, vandals, and freezing temperatures. difficult to install in soils with coarse fragments. Psychrometers measure total soil water potential (bars) in the range of about 50 to 0 bars (sensitivity decreases from about 2 to 0 bars). Temperature can be measured also and calibration is independent of soil type. Calibration is required approximately every 6 months. Moisture resistance blocks measure matric potential or volumetric water, depending on calibration. The effective range is from 0 to about 10 bars. These are inexpensive, simple, and are applicable to a wide range of moisture contents. They are often unreliable, have low precision and poor accuracy. They must be calibrated for each soil. Electrical heat dissipation blocks measure matric potential or volumetric water. The range is from 0 bars to The bridge is relative inexpensive but the sensors are expensive. Precision is low at moisture contents less than 10 bars. The neutron soil moisture probe measures volumetric soil water content from 0 to saturation. Resolution is low. This depends on the geometry of the probe and the moisture content of the soil but at best gives the average water content of a sphere of soil with a diameter of about 15 cm. As water content decreases the diameter of the sphere increases. Precision is good. This depends on the number of Accuracy is good. Sampling is required for each sail to check accuracy of the calibration curve. Unreliable values are obtained near the soil surface unless a shield is used or a special surface probe is used. Radiation hazard requires special storage, transportation and handling procedures. A special license is required,

The literature is divided on the question of whether or not all soils measured with the neutron probe should be calibrated. Rawls and Asmussen (1973) suggest that one calibration curve will suffice for some studies. Cannell and Asbell(1974), however, suggest in some situations It may be important to calibrate to a specific soil. Change in bulk density has an effect on neutron probe measurements (Holmes, 1966; Luebs et al., 1968; Olgaard and Haar, 1967)/The amount of absorbing elements (e.g. boron and iron) and hydrogen sources other than water also affect neutron probe measurements (Holmes, 1956).

The accuracy of the moisture measurements is of critical importance. Confidence intervals of moisture content **levels** of each horizon within the SMCS on each site should be calculated.

Soil temperature measurements are made more routinely than those for soil moisture. As a minimum, most surveys should set up a soil temperature transect and compare the mean annual soil temperature with the weather station mean annual air temperature for the same year. Then one can derive a long-time mean annual soil temperature from this relationship and the long-time climatic data for that area. It would be worthwhile to moniter soil moisture and temperature also for areas where laboratory characterization is planned.

The location of each transect should be measured as a minimum on the 1st or 15th of January, April, June, July, August and October each year to establish mean annual and mean summer temperature. In mountain areas or areas with heavy snow pack, a couple sites should be located near a main road so that the January and April temperature can be taken, and not omitted. Reading soil temperature four times a year is not reliable under some conditions and monthly readings are necessary.

The kind of vegetation influences mean annual and mean summer soil temperature (Munn, Buchanan, and Nielsen, 1978). They indicate that there is little influence of kind of vegetation on the winter soil temperatures. The summer soil temperature at 50 cm depth is about SC warmer in the meadow than in the forest. The mean summer air temperature is about 2C higherthan the mean summer soil temperature for the meadow site and 5C higher than the mean summer soil temperature for the soil site.

It will take years to validate our soil moisture temperature lines by collecting onsite soil moisture temperature data. Because of this, we are better off to study a few transects in detail over a period of years. In these studies, we should relate climatic and soil data for the year's study. From this relationship, one can decide the mean annual soil temperature and moisture regime most prevalent in the last hundred years or the period of climatic records. One must use these long-term data for drawing the general lines one uses to separate soil moisture and temperature regimes in mapping. Hopefully, vegetation, soil color, organic matter, base saturation, depth to carbonate, salt, etc., will correlate with these changes and can be used in the survey.

We should make soil moisture and temperature measurements within plant communities, not at **randon.** Ordinary point transects will not get the kind of information needed to establish the basic facts to understand inter-relationships.

### Charge 3 Recommendations:

- 1. The only way to arrive at meaningful temperature and moisture regimes is through correlation with plant communities. Tolerance limits must be established. Measurements should be made within a community and throughout its range of distribution. Total environmental parameters should be measured over a wide network of stations.
- 2. Moisture release curves should be established for soil in plant communities.
- 3. Temperature and moisture should be measured at several depths to test the moisture control section and moisture regimes.

#### REFWENCES CITES

- Cannelly, G. H., and C. W. Asbell. 1974. The effects of soil-profile variations and related factors on neutron-moderation measurements. Soil sci. 166:262-265
- Daubenmire, R. 1968a. Plant communities: a textbook of plant synecology. Harper & Row, New York. 300 p.
- Daubewire, R. 1968b. Soil moisture in relation to vegetation distribution in the mountains of northern Idaho. Ecology 49:431-438
- Herbel, C. H., and L. H. Gile. 1973. Field moisture regimes and morphology'
   of some aird-land soils in New Mexico. In Field soil water regimes.
  Amer. Soc. Agron. Spec. Publ. No. 5.
- Holmes, J. W. 1956. Calibration and field use of the neutron scattering method of measuring soil water content. Aust. J. Appl. Sci. 7:45
- Holmes, J. W. 1966. Influence of bulk density of the soil on neutron moisture meter calibration. Soil Sci. 102:355-360
- Luebs, R. E., M. J. Brown, and A. E. Laag. 1968. Determining water content of different soils by the neutron method. Soil Sci. 106:207-212
- Munn, L. C., B. A. Buchanan and G. A. Nielsen. 1978. Soil temperatures in adjacent high elevation forests and meadows of montana. Soil sci. Soc. Am. J. 42:982-983
- Munn, L. C., G. A. Nielsen and W. F. Muggler. 1978. Relationship of soils to mountain and foothill range habitat types and production in western Montana. Soil Sci. Soc. Am. J. 42:135-139
- Newhall, F. 1976. Calculation of soil moisture regime from the climatic record. USDA-SCS. Rev. 5. (Mimeo.)
- Nichols, J. D., and J. F. Stone. 1970. Evaluation of soil moisture measurements in Oklahoma as soil characteristics for classification. Soil sci. Soc. Am. Proc. 34:638-641
- Olgaard, P. L., and V. **Haar.** 1967. On the sensitivity of subsurface neutron moisture gauges to variation in bulk density. Soil Sci. 105:62-64
- Rawls, W. J., and L. E. Asmussen. 1973. Netron probe field calibration for soils in the Georgia coastal plain. Soil Sci. 116:262-265
- Thomas, B. R., G. H. Simonson, and L. Boersma. 1973. Evaluation of critia for separating soil with xeric and udic moisture regimes. Soil Sci. Soc. Am. Proc. 37:738-741

- Thornthwaita, C. W. 1948. An approach toward a rational classification of climate. **Geog.** Rev. **38:55-94**
- Thornthwaite, C. W., and J. R. Mather. 1955. The water budget and its use in irrigation. <u>In</u> Water: the yearbook of agriculture, 1955. USDA, U.S. Govt. Printing Off., Washington, D.C. pp.346-358
- Zobeck, T. 1980. Soil moisture regimes along a vegetation transect in central New Mexico. Dissertation, Agronomy Department, New Mexico State University, Las Cruces.

# **SAMPLE**

### FIELD IDENTIFICATION LEGEND

			FIELD IDENTIFI	CATION LEGEND			Works	heet 10/79
MAP Symbol	MC4V	MAPPING UNIT NAME	CLASSIFICATION	COLOGICAL SITE	Y SPECIES	PRECIP. ZONE	MODAL PROFILE	REMARKS
AHF		AB-MA-Rock outcrop complex 30 to 70 % Slopes					•	
	3 s	AB extremely cobbly loam, 30 to 70 %	Aridic Argixerolls loamy-skeletal, mixed, frigid	Ipland Stony Loam				ATTACHMENT
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### SOIL-VEGETATION-CLIMATE RELATIONSHIPS

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C4700H		ARGIBONOLLÍS, UDORTHENTS, GLOSSONORALES		GOLLS BOROLLS BORALFS	HAPLUSTOLLS,	ARGIUSTOLLS,C USTOCHREPTS,L		HAPLARGIDS, CA	LCIORTHIDS, PA	LEORTHIOS.	GREAT GROUPS
-		UDIC ANGIDOROLLS		IBOROL L S				USTOLLIC	HAPL ARGIO	<del></del>	
	RYOBOROLLS AYOCHREPTS	TYPIC UDORTHENTS EUTRIC	MOLLIC EUT	LOBOROLLS TROBORALES	ALCO MATERIALIS	TYPIC HAPTERSTOLES	AREJE ARGASTOLES AREJE HAVIDS TOLLS AREJE HAVIDSTALES AREJE CALGUSTOLES	. USTOLLIC F	CALCIORTHD PALEORTHID	TYPE HARLARGO TYPE CALDOTTHE TYPE PALECATION LITTING CALDOTTHE	
COLO	NONE	SNOWS CYCESSONATES	NONE	ROBORALFS WARM	MOIST	HOME	ORY .	LITHIC USTOLL	IC CALCIORITHO	NOME	SUBGAÇUP
ነርቲኒ ሣለሃድ፤ ይያመድር – በ/ድልሚ ይነድ ይላታ የመድመ	COUTLAS-FIR— CHSELMANH SPRUCE	DOUGLAS FOR—"> PONDERDOA PINE	Ромоспоры дага	AMPER	MHTOL PUZ- ALIGATON AMPER	ONE SECTI AMINER		.30TOL - LECHUSUHCLA	BLACK GRAMA - TOBOSA	CAESOTEBUSX- TAABUSH	POTENTIAL NATURAL VEGETATION
erbert Fo	Dengar-Far	f darign chican Alum	Pmc	<u></u> ←	tymytr Bryse Pers	<u></u>		Spied Dipck	Ciona (	Cressiehusk	
		Mounton Orang  Research		<del>-</del>	A/Gresce4 Junio Skumbough	Summe Olive Grand	<b>(</b>	<u>.</u>	Zela Papayaya Tebera	te see	\$ELECTEO #EY
		500-0000	Gambel Coa	1 11 #1-13-15#E	(	Gerena Georg Oak	L <u>rek</u> ngu <u>ida</u>	<del></del>			SPECIES: RANGE OF
	, <del></del>	Mauricia Mully	Kennery Murrous	<u>-</u>	Squire   Park	Y/Meangaria Mean Meane	<u>inalpergiana</u>	<del></del> 3	· ·		ADAPT KBILITY
	·				<u>Vine Masquille</u>	LIRIS D'AVILLE	Signerio Cromo	Jane Cropray	·		
10me orest Pre-filligate	ji 20 Pine PASY is ni by a Douglos-fic or Juniper PNY in Har Juniper Signt	— Ponderosa • Which Douglas-	near the se (Apuntain by	j ed Jeniger PNV outhwest base of o Heiry-leaf We IV In which Onese panent,	Corvize huma-nemol-ageny-		ra Walte Pine a o tals PNY ia la orca,		ine Player and above	funiper in the up Prine - Alligator has a single s ed with Utah Ju	Juniper Zone tem and can

### ABSTRACT

# SOIL MOISTURE REGIMES ALONG A VEGETATION TRANSECT IN CENTRAL NEW MEXICO

BY

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Doctor of Philosophy in Agronomy

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Las Cruces, New Mexico, 1980

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Problems have arisen in the western United States in classifying soils due to disagreements among soil scientists in estimating the location of soil moisture regimes in the field. Estimates are currently made by correlating the plant community on an area with an assumed soil moisture regime. No previous studies have measured soil moisture regimes and correlated the results to plant communities in New Mexico. The objectives of this study were to correlate major plant communities in New

Mexico with measured soil moisture regimes and compare the measured results to hand-calculated estimates.

Mean annual soil temperatures at a depth of 50 cm, precipitation, and soil moisture regimes were determined for eight sites transecting the following vegetative communities: blue grama (Bouteloua gracilis Lag.) grasslands, one-seed juniper (Juniperus monosperma (Engelm.) Sarge.) and pinyon pine (Pinus edulis Engelm.) woodlands, pinyon pine and alligator juniper (J. deppeana Steud.) woodlands, and ponderosa pine (P. ponderosa Lawson) forests. Forested plots were compared to open plots at all but the blue grama grasslands sites. All sites were found to be in the mesic soil temperature regime (10.1-14.4C). The soil temperatures on the open plots were all significantly higher (P < 0.05) than the forested plots. Open plots were an average of 2.2C warmer than forested plots at the same site.

Precipitation generally increased with elevation (536-837) mm). Precipitation on the open plots was generally significantly different (P < 0.05) from the forested plots. Eleven to 48 percent of the precipitation was intercepted.

Soil moisture data from the field sites were used to determine the soil moisture regime for each of three soil moisture control sections. The three soil moisture control sections were computed on the basis of three initial soil moisture content levels. The initial soil moisture contents were oven-dry, airdry, and 15 bars. The soil moisture control section was also

estimated from a finite difference solution of the soil moisture diffusion equation.

Blue grama grasslands were classified into the ustollic subgroup of the aridic soil moisture regime. In lower areas of the same landscape, where water may collect or run over the site, a deep dark surface may form. Soil in this situation was classified in the pachic subgroup of the ustic moisture regime. The classification of the one-seed juniper and pinyon pine woodlands ranged from the aridic to the typic subgroup of the ustic moisture regime. Pinyon pine and alligator juniper woodlands were classified in the same moisture regimes as the one-seed juniper and pinyon pine woodlands. The ponderosa pine forest soil classification ranged from the typic to the udic subgroup of the ustic soil moisture regime.

Caution should be exercised in using plant communities to predict soil moisture regimes. Single plant communities may be within more than one soil moisture regime. Open sites within a forest may be within a different soil moisture regime than sites occupied by trees.

### Appendix B

SIMULATION OF SOIL WATER TRANSPORT

IN A **SOIL** PROFILE

# SIMULATION OF SOIL WATER TRANSPORT IN A SOIL PROFILE

Computer-assisted simulation models are often used to gain insight into dynamic processes. The transient flow of water in soil is a dynamic process that can be simulated on modern digital computers with comparative ease. This section describes one technique to describe isothermal transient flow of water in soils. Little mathematical knowledge is necessary to apply this model to soils of varying characteristics. The model was used to predict the boundaries of the soil moisture control section for several initial soil moisture conditions.

### Governing Equations

In the following discussion, the z-direction is vertical and positive from the soil surface downward.

The following two equations are combined to describe the flow of wafer in soils:

1. Darcy's Law: 
$$q = -K(\theta) \frac{\partial \phi}{\partial z}$$
, (5)

where: q = flux (cm/day)

K = hydraulic conductivity (cm/day)

 $\phi$  = total hydraulic head (cm)

z = downward direction (cm)

8 = water content (cm/cm),

The flux of water is proportional to, and in the direction of, the driving force. K is the proportionality constant, known as the hydraulic conductivity. The total hydraulic head ( $\phi$ ) is the algebraic sum of the hydraulic head (H) and the gravitational potential (z) (i.e.,  $\phi = H + z$ ).

### 2. The continuity equation:

$$\frac{\partial e}{\partial t} = -\frac{\partial q}{\partial z} , \qquad (6)$$

where t is time in days.

This relationship is derived from the principle of the conservation of mass. The time rate of change of water must be equal to the change in flux.

Combining (5) and (6) yields:

$$\frac{\partial \theta}{\partial \mathbf{r}} = \frac{\partial}{\partial \mathbf{z}} \left( \mathbf{K}(\theta) \frac{\partial \phi}{\partial \mathbf{z}} \right) \qquad . \tag{7}$$

By substituting the algebraic sum of the hydraulic head and gravitational potential, (7) now becomes:

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z} \left( K(\theta) \frac{\partial H}{\partial z} \right) - \frac{\partial K(\theta)}{\partial z} , \qquad (8)$$

where H is the hydraulic head in centimeters.

In this simulation, equation (8) is solved subject to the following boundary conditions:

$$t = 0$$
,  $z > 0$ ,  $\theta = \theta_{\dot{1}} = f(z)$   
 $t \ge 0$ ,  $q - r$   
 $t > 0$ ,  $z = L$ ,  $\frac{dH}{dz} = 0$ 

where: L = depth of the soil profile (cm)

H = hydraulic head (cm)

r = rainfall rate (cm/day)

 $\theta$ , z initial volumetric wetness (cm/cm) .

### Description of the Computer Model

This model is similar to those developed by Hillel (1975), Hillel and Van Bavel (1976), Van Der Ploeg and Benecke (1974), and Van Keulen and Van Beek (1971). A listing of this model and sample output follows this discussion.

The program is written in Continuous System Modeling Program III (CSMP III) (IBM Corporation, 1972). This language allows the user to simulate dynamic processes without lengthy statements that may otherwise be required as in other more popular languages. In the following discussion, words that are entirely capitalized refer to terms used in the model.

The INITIAL section of the program sets initial conditions of the model that will not be changed at a later time without resetting the INITIAL section. In the present model, several data inputs are Initialized in this section.

Data inputs include NL, TCOM, and the FUNCTIONS MOIST, RAINTB, SUCT1, SUCT4, CONDT1, and CONDT4. The FUNCTIONS may be considered as tables of values in pairs. The first number in the function is paired with the second number; the third number is paired with the fourth; and so on. For example, FUNCTION MOIST initializes the soil

moisture with depth for the profile. The first number in the pair is the depth, and the second is the volumetric moisture content. FUNCTION RAINTB tabulates time in days as the first value and rainfall in cm/day as the second value. FUNCTIONS SUCT1 and SUCT2 list soil wetness and matric potentials expected at the corresponding wetness values. Similarly, FUNCTIONS CONDT1 and CONDT2 list soil wetness as the first value and hydraulic conductivity as the second.

In this simulation, the soil profile was broken into a number of compartments (NL), each NL/75 cm thick. The compartments are referred to as TCOM(1) through TCOM(NL), with TCOM(NL) being the last compartment. The depths studied are set in DO 110. Within DO 100, the initial volumetric wetness (ITHETA), the initial water Content of the entire profile (IWATER), and the initial amount of water in each compartment are determined.

In the DYNAMIC section, calculations are made and updated each time step set by the final TIMER card near the end of the program. The following calculations are updated in the DYNAMIC section in the model:

- 1. The water content of each compartment was calculated from the initial water content, IVOLW, and the time rate of change of the net flux into the respective department, NFLUX.
  - 2. The volumetric water content, THETA, was set at 0.3266.
- 3. The hydraulic head or matric potential, ?iPOT, was taken from the FUNCTION SUCT table for each compartment. The matric

ment is a function of the water content in the compartment.

- 4. The hydraulic conductivity, COND, was derived from the CONDT functions in a manner similar to number 3 above.
- 5. The total potential, HPOT, was the sum of the matric potential and the gravitational potential represented by DEPTH.

  The gravitational potential was the negative of the depth, taking the soil surface as the reference level.
- 6. The average conductivity, AVCOND, was calculated for all but the first cell. The average conductivity of the first cell was equal to the conductivity of the first cell.
  - 7. The flux, FLUX, was computed following Darcy's law.
- 8. During each iteration, the rainfall was taken from the FL'NCTION RAINTB table via the RAIN equation. If there was no rainfall, the infiltration rata was zero, and the flux into the first compartment was set at zero. If there was rainfall, the flux into the first compartment was equal to the infiltration capacity or rainfall rate, whichever was lower. In the RAIN equation, the AFGEN statement causes the computer to select a linear interpolation in generating output between the time-versus-rainfall pair of values from the FUNCTION RAINTB statement. The rainfall falls at a rate of 2.5 or 7.5 cm/day in this model. This rate of water application may not be the same rate that is used in empirically deriving a soil moisture control section in the field. The Soil Taxonomy does not specify a water-application rate.

- 9. Cumulative infiltration, CUMINF, was found by integrating over the course of the simulation. The cumulative water, CUMWTR, was calculated by summing the volumes of water for each compartment at each iteration.
- 10. The TIMER statement sets the finishing time of the simulation at three days. Output was printed at one-day intervals, as set by OUTDEL. Iterations were taken at 0.001-day intervals. Longer intervals were tested, but the program lost stability at these longer intervals. The stability of the program is associated with the integration method employed, a fourth-order Runge-Kutta method in this case. The Runge-Kutta continually adjusts the DELT to meet specific criteria written into the integral process, and a larger initial DELT apparently causes internal problems with this integration method. For more details, see the CSMP Reference

In using this simulation technique, it was assumed that unsaturated hydraulic conductivity and soil suction are unique, single-valued, and continuous functions of the water content. The unsaturated hydraulic conductivity was calculated by the use of a computer program written by Van Genuchten (1978). Input data into his program include soil moisture release curve data and saturated hydraulic conductivity for each depth sampled. This information was collected for Fort Stanton I and may be found in Appendix A, Table 42. The Van Genuchten program calculates relative conductivity, absolute conductivity, and their log values,

as well as diffusivity and the log of the diffusivity. The values obtained with the Van Genuchten model are found in the FUNCTION SUCT and FUNCTION CONDT statements in the model currently under study.

```
SIMULATION OF SOIL WATER TRANSPORT IN A SOIL PROFILE
                    GLOSSARY OF SYMBOLS
M
\boxtimes
     AVCOND = AVERAGE HYDRAULIC CONDUCTIVITY (CM/DAY)
     COND = HYDRAULIC CONDUCTIVITY (CM/DAY)
×
     CUMINF = CUMULATIVE INFILTRATION (CM)
×
M
     CUMWTR = TOTAL WATER CONTENT OF TRE SOIL PROFILE (CM)
     DEPTH = DEPTH OF THE MIDPOINT OF EACH COMPARTMENT (CM)
M
             = FLOW RATE OF SOIL WATER (CM/DAY)
×
     FLUX
     FLXNLL = FLOW RATE OUT OF THE LAST COMPARTMENT (CM/DAY)
\boxtimes
     HPOT = HYDRAULIC POTENTIAL (CM)
     INFILT = INFILTRATION RATE (CM/DAY)
\boxtimes
     ITHETA - INITIAL VOLUMETRIC WETNESS (CM/CM)
             ■ INITIAL AMOUNT OF WATER IN EACH COMPARTMENT (CM)
\boxtimes
     IVOLW
     IWATER = INITIAL WATER CONTENT IN THE WHOLE PROFILE (CM)
\star
             = MATRIC POTENTIAL (CM)
     MPOT
     NFLVX = NET FLOW RATE OF SOIL WATER IN EACH COMPARTMENT (CM/DAY)
\bowtie
     RAIN = RAINFALL RATE (CM/DAY)
M
     TCOM = COMPARTMENT THICKNESS (CM)
M
     THETA = VOLUMETRIC WETNESSZOF EACH COMPARTMENT (CM/CM)
M
M
     VOLW
             = AMOUNT OF WATER IN EACH COMPARTMENT (CM)
×
M
                    SIMULATION PROGRAM
M
       STORAGE TCOM(80), DEPTH(80), ITHETA(80), COND(80),...
       AVCOND(80), MPOT(80), HPOT(80), FLUX(80)
       DIMENSION THETA(80)
       FIXED I.NL
       TNTTTAL
       NOSORT
      PARAMETER NL=15
       TABLE TCOM(1-15)=15*5
       NLL=NL+1
       IWATER=0.
       DEPTH(1)=0.5*TCOM(1)
       DO 110 I-2,NL
       DEPTH(I) = DEPTH(I-1) + 0.5 * (TCOM(I) + TCOM(I-1))
110
       CONTINUE
       DO 100 I=1,NL
       ITHETA(I)=0.080
       IWATER = IWATER + TCOM(I) + ITHETA(I)
```

```
NFLUX(I)=0.

IVOLW(I)=ITHETA(I)*TCOM(I)

100 CONTINUE

FUNCTION RAINTB=(0.0,7.50,1.0,7.50,1.001,0.0,5.0,0.0)

FUNCTION SUCT1=(.0425,.541E10,.045,.138E10,.0475,.379E9,.05,.111E9,...

.0525,.346E8,.055,.114E8,.0575,.393E7,.06,.142E7,.0625,.536E6,...

.0636,.501E6,...

.0645,.251E6,...

.0657,.126E6,...

.0674,.631E5,...

.0704,.266E5,...

.0738,.133E5,...
```

```
.0575,.289E-15,.06,.726E-14,.0625,.16E-12,...
       .0636,.200E-12,...
       .0645,.177E-11,...
       .0657,.156E-10,...
       .0674,.138E-9,...
       .0704,.210E-8,...
       .0738,.185E-7,...
       .0785,.168E-6,...
       .0850,.146E-5,...
       .0939,.127E-4,...
       .1061,.112E-3...
       .1229,.978E-3,...
       .1455,.842E-2,...
       .1755,.696E-1,...
       .2129,.518E0,...
       .2534,.308E1,...
       .2878,.126E2,...
       .3094,.337E2,...
       .3198,.630E2,...
       .3240,.934E2,...
       .3266,.210E3)
FUNCTION CONDT4=(.0525,.409E-28,.055,.126E-26,.0575,.331E-25,...
       .06,.76E-24,.0625,.153E-22,.065,.275E-21,.0675,.442E-20,...
       .07,.643E-19,.0725,.851E-18,.075,.103E-16,.0775,.115E-15,...
       .08,.119E-14,.0825,.115E-13,...
       .0866,.379E-12,...
       .0883,.267E-11,...
       .0905,.188E-10,...
       .0933..132E-9....
       .0968,.111E-8,...
       .1012,.658E-8,...
       .1067,.480E-7,...
       .1137..330E-6....
       .1224,.232E-5,...
       .1333,.162E-4,...
       .1471,.114E-3,...
       .1643,.796E-3,...
       .1856, .551E-2, ...
       .2118,.3728-1,...
       .2426..236E0....
      .2760,.131E1,...
       .3071,.576E1,...
       .3301,.182E2,...
       .3435,.413E2,...
       .3548,.307E3)
       DYNAMIC
       NOSORT
       VOLW=INTGRL(IVOLW,NFLUX,15)
       DO 200 I=1,NL
       THETA(I) = VOLW(I) / TCOM(I)
```

### IF(THETA(I).LE.0.3266) GO TO 10

```
PARAMETER NL=15
       TABLE TCOM(1-15)=15*5
FUNCTION RAINTB=(0.0,7.50,1.0,7.50,1.001,0.0,5.0,0.0)
FUNCTION SUCT1=(.0425,.541E10,.045,.138E10,.0475,.379E9,.05,.111E9,...
       .0525,.346E8,.055,.114E8,.0575,.393E7,.06,.142E7,.0625,.536E6,...
       .0636,.501E6,...
       .0645,.251E6,...
       .0657,.126E6,...
       .0674,.631E5,...
       .0704,.266E5,...
       .0738,.133E5,...
       .0850,.335E4,...
       .0939..168E4....
       .1061,.841E3,...
       .1229,.422E3....
       .1455..211E3,...
       .1755,.106E3,...
       .2129,.531E2,...
       .2534,.266E2,...
       .2878,.133E2,...
       .3094,.668E1,...
       .3198,.335E1,...
       .3240..168E1...
       .3266,.0)
FUNCTION SUCT4=(.0525,.186E7,.055,.175E7,.0575,.164E7,.06,.153E7,...
       .0625,.142E7,.065,.131E7,.0675,.12E7,.07,.109E7,.0725,.98E6,...
       .075,.871E6,.0775,.761E6,.08,.651E6,.0825,.541E6,...
       .0866..501E6...
       .0883,.251E6....
       .0905,.126E6,...
       .0933,.631E5,...
       .0968,.316E5,...
       .1012,.158E5,...
       .1067,.794E4,...
       .1137,.398E4,...
       .1224,.200E4,...
       .1333,.100E4,...
       .1471,.501E3,...
       .1643,.251E3,...
       .1856..126E3....
       .2118,.631E2,...
       .2426,.316E2,...
       .2760,.158E2,...
       .2999,.944E1,...
       .3301,.398E1,...
       .3435,.200E1,...
       .3548,.0)
FUNCTION CONDT1=(.0425,.328E-25,.045,.249E-23,.0475,.15E-21,...
       .05,.729E-20,.0525,.294E-18,.055,.996E-17,...
```

```
.0575,.289E-15,.06,.726E-14,.0625,.16E-12,...
       .0636,.200E-12,...
       .0645,.177E-11,...
       .0657,.156E-10,...
       .0674,.138E-9,...
       .0704,.210E-8....
       .0738..185E-7,...
       .0785..168E-6...
       .0850,.146E-5,...
       .0939,.127E-4,...
       .1061,.112E-3,...
       .1229,.978E-3,...
       .1455,.842E-2, . .
       .1755,.696E-1,...
        .2129,.518E0,...
        .2534,.308E1,...
        .2878,.126E2,...
        .3094,.337E2,...
        .3198,.630E2,...
        .3240,.934E2,...
        .3266,.210E3)
FUNCTION CONDT4=(.0525,.409E-28,.055,.126E-26,.0575,.331E-25,...
        .06,.76E-24,.0625,.153E-22,.065,.275E-21,.0675,.442E-20,...
        .07,.643E-19,.0725,.851E-18,.075,.103E-16,.0775,.115E-15,...
        .08,.119E-14,.0825,.115E-13,...
      .0866,.379E-12,...
        .0883,.267E-11,...
        .0905,.188E-10,...
        .0933,.132E-9,. . .
        .0968,.111E-8,...
        .1012,.658E-8,...
        .1067,.480E-7,...
        .1137,.330E-6,...
        .1224,.232E-5,...
        .1333,.162E-4,...
        .1471,.114E-3,...
        .1643..796E-3....
        .1856, .551E-2, ...
        .2118,.372E-1,...
        .2426..236E0...
        .2760,.131E1,...
        .3071,.576E1,...
        .3301,.182E2,...
        .3435,.413E2,...
        .3548..307£3)
        TIMER FINTIM=3.0, OUTDEL=1.0, DELT=0.001, PRDEL=1.0, DELMIN=1.0E-20
        OUTPUT CUMWTR, CUMINF, IWATER
END
                                               START TIME = 0 .0
TIMER VARIABLES
                    RKS
                             INTEGRATION
  DELT
               DELMIN
                            FINTIM
                                         PRDEL
                                                     OUTDEL
                                                                  DELMAX
                                                                 1.0000
                           3.0000
 1.00000D-03 1.00000D-20
                                        1.0000
                                                     1.0000
```

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### WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE OF THE COOPERATIVE SOIL SURVEY

#### Soil Survey Interpretations Committee 5

The following charges were given to the committee:

- 1. Develop methods of displaying interpretations of multi-taxa mapping units in Order 3, 4, and 5 soil surveys.
- 2. Develop models for use of soil potential ratings for rangeland and wildland interpretations.

Following are some items we must consider in making interpretations:

- a. A soil survey is an inventory of soil resources with meaningful interpretations that can be consistently made within prescribed parameters.
- b. The interpretations made in a soil survey are not designed so that they can be used like a cookbook. Professional management judgment must be utilized. The survey needs to provide the manager with the tools he needs to enable him to come to proper decisions.
- c. The mapping unit is what is mapped. It includes one or more taxonomic units plus inclusions of similar and contracting soils. However, a benchmark must be used in determining the interpretations for each taxonomic unit. These must have described parameters so the taxonomic unit becomes the benchmark.
- d. Information should be transferable from one survey to another. New interpretations need not be developed for every survey, but information from other surveys should be used. The taxonomic unit is what is now used for the transfer of the information.
- e. Present urgent needs for soil surveys dictate that good interpretations need to be made quickly and with somewhat limited data. It is important that much of the work can be machine generated as we do tables in the soil survey manuscript.
- f. Taxonomic unit must be based on more than a single pedon. Ample pedons and notes are collected to support the mapping unit as well as to substantiate that there are significant areas of the soils.
- g. Soil surveys decrease in specifity for a particular area of landscape as the orders go from 3 to 4 to 5. The type of interpretation that can be made becomes more general. As an example, flip charts and maps good for broad planning can be made for different interpretations, but have little value for on-site or intensive planning.
- <u>Charge 1</u>: Develop methods of displaying interpretations of multi-taxa mapping units in Order 3, 4, and 5 soil surveys.
- Alternative 1: Describe mapping unit description in usual manner giving the components and percentage of the components in the unit along with inclusions. Then provide computer generated tables. Tables can be combined into various combinations. One State consolidated Tables H, J, and K into two tables. The first table had column headings: depth, USDA Texture, Unified, ASHTO, 3" fraction, clay content, soil reaction, salinity, hydrologic group and organic matter. The second contained depth, permeability, AWC, shrinkswell, erosion factors, corrosivity, cemented pan, bedrock, and potential frost action.
- Alternative 2: Use of Computer Assisted Writing (CAW) for preparation of the mapping unit descriptions of associations and complexes. Other agencies can develop addendum statements to fit their special needs. These additional statements may or may not be used in the compiled manuscript. Only that part of the mapping unit planned for publication is stored in the SCS word processor, while any additional interpretative data or data for local application are stored in the cooperating agency's word processor. This method allows for all the long range or well established interpretations to be stored along with interpretations that are being tested or only have local application.

This system has a wide application, and statements can be developed for almost all kinds of mapping units and for surveys of different orders.

This system works well for soil surveys planned for publication, but the information is also needed quickly for planning. (Attachment No. 1)

- Alternative 3: Soil Map Unit Description in chart form These are filled out for each mapping unit. An advantage is that items are in the same place on each chart. Also, there is only one set of charts per mapping unit with information about a mapping unit in one place, and not in several tables or text. Disadvantage of being hand generated. Acceptable for special needs. A computer generation of this type of display would make it easier and quicker to make.
- Alternative 4: Develop ratings for each of the major components, as in Alternatives 1 through 3, but also develop a composite rating for the mapping unit. These mapping unit ratings would be based on the individual component ratings. Acceptable for technical guides or special interpretive handbooks.
- <u>Charge 2</u>: Develop models for use of soil potential ratings for rangeland and wildland interpretations.

More work and exploration is needed for development of the soil potentials for rangeland and wildland. This should be a continued committee charge. There is a need to explore methods that would apply to Order 5 soil surveys.

What parameters are needed to set up potential ratings? This is difficult because of the economic and other data available to develop these ratings. We need to work with the range personnel in developing a potential rating program and the kinds of input needed from them to obtain the ratings.

For range, the first phase is to develop the range sites with potential plant communities. The range sites must be closely controlled, or there may be greater difference in plant composition and production within range sites than between range sites. The range sites must be developed by range conservationists in conjunction with soil scientists. There should be interstate correlation of range sites.

In relation to range, some items for which potentials can be developed are reseeding, early spring grazing, late season grazing, etc. These must be developed by range conservationists, but based on soil characteristics.

Potential for wildland has had many problems because of difficulty to tie tangible economic returns to it. Interpretations for wildlife have been worked out for mapping units in some surveys, but are difficult to make because interactions of different mapping units are necessary for the wildlife. Some soils are well suited for wildlife food production, but may offer little cover and may not have a source of water, while others may offer good cover.

There is a recent proposal to make interpretations for major wildlife by taxonomic units of the general soils map, and to develop potentials for broad landscape units. The soil will be rated by defined criteria for each habitat element, taking into account the potential native plant community that is supported by the soil.

These data can then be used to determine the potential of broad landscape units (general soil map units) to support various wildlife species or wildlife ecosystems, either annually or seasonally. These potentials should also be determined by committee action of appropriate disciplines--not a soil scientist or wildlife biologist individually. The resultant potential ratings will be documented as suggested in Section 404 of the National Soils Handbook, Part II: Soil Potential Ratings.

Presentation of the habitat element ratings in computer generated tables will become a part of area or county technical guides and soils handbooks. Its use as part of a soil survey manuscript, or other published documents, will be optional at the discretion of the State Conservationist.

Presentation of the wildlife habitat potential ratings can also become a part of the area or county technical guides, soils handbooks, and soil survey manuscripts. It will be discussed in either the introductory text of the wildlife section by general soil map units, or in the broad land use consideration section. Wildlife needs and management will not be discussed in

the individual mapping unit descriptions, unless the soil has unique properties that are required for wildlife propagation or survival. This will reduce needless bulk from these documents.

### Recommendations:

The committee recommends that charges be continued and the respective disciplines to be involved in future committees develop the rangeland and wildland potentials.

### Committee Members:

<ol><li>Brownfield,</li></ol>	Chai rnan	L. Langan
R. Arkley		L. D. Marriage
D. Ball		D. Post
J. Chugg		R. Pratt
W. crane		John Rodgers
R. Dansdill		H. Rounsaville
W. Dollarhide		H. Sato
A. Ford		<b>W</b> Sauerwein
R. Heil		B. Smith
<b>R.</b> Hoppes		R. Tew

### ATTACHMENT 1\*

\$11061¢Uvi-Vassar association, very steep. \$717his map unit is on mountainsides. The natural vegetation is mainly coniferous trees. Slope is 35 to 65 percent. Elevation is 2,800 to 4.500 feet. The average annual precipitation is about 36 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 90 days.

\$IOIThis unit is about 60 percent Uvi loam and 25 percent Vassar silt loam. The Uvi soil is mainly on south-facing slopes, and the Vassar soil is mainly on north- and east-facing slopes.

\$101Included in this unit are small areas of a soil that is similar to the Uvi soil but has a clay loam subsoil and a soil that is similar to the Vassar soil but is moderately deep to decomposing granite.

\$101The Uvi soil is very deep and well drained. It formed in loess and in residuum derived from granite. Typically, the surface is covered with a mat of organic material 2 inches thick. The upper 7 inches of the surface layer is brown and yellowish brown loam. The lower 11 inches is pale brown loam. The upper 10 inches of the subsoil is pale brown loam. The lower part to a depth of 60 inches or more is light yellowish brown loam.

\$101Permeability of the Uvi soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is very rapid, and the hazard of water erosion is very high.

\$101The Vassar soil is deep and well drained. It formed in volcanic ash over residuum derived from granite. Typically, the surface is covered with a mat of organic material 2 inches thick. The surface layer is yellowish brown silt loam 6 inches thick. The subsoil is light yellowish brown silt loam 18 inches thick. The upper 15 inches of the substratum is pale brown coarse sandy loam. The lower part is very pale brown loamy coarse sand 14 inches thick. Decomposing granite is at a depth of 53 inches.

\$101Permeability of the Vassar soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches. Runoff is very rapid, and the hazard of water erosion is very high.

\$101This unit is used for woodland.

\$101The potential natural plant community on the Uvi soil is mainly grand fir, Douglas-fir. mallow ninebark, and elk sedge. This soil is well suited to the production of grand fir and Douglas-fir.

\$101The site index for grand fir on the Uvi soil is about 55. This soil can produce about 8,400 cubic feet per acre of trees 0.6 inch or more in diameter or 12,200 board feet of merchantable timber 12.6 inches or more in diameter. Potential production is from an unmanaged stand of trees 80 years old.

\$101The potential natural plant community on the Vassar soil is mainly western redcedar, western white pine, pachystima, and mountain blueberry. This soil is well suited to the production of western redcedar, grand fir, and western white pine.

\$1017he site index for western white pine on the Vassar soil is about 75. This soil can produce about 11,000 cubic feet per acre of trees 0.6 inch or more in diameter or 42,600 board feet of merchantable timber 12.6 inches or more in diameter. Potential production is from an unmanaged stand of trees 80 years old.

\$101The main concerns in producing and harvesting timber on these soils are the hazard of water erosion, slope, and the hazard of plant competition. Minimizing the risk of erosion is essential in harvesting timber. Because the volcanic ash in the surface layer of the Vassar soil is highly erodible, very careful management of timber is needed to minimize the risk of water erosion. The loss of the surface layer can result in a lower site index. The steepness of slope limits the kinds of equipment that can be used in forest management. To avoid excessive erosion, construction and maintenance of logging roads, skid trails, and landings should be carefully planned. If site preparation is not adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

\$1017his unit is suited to grazing when the tree canopy is opened by logging, fire; Or other disturbance. Forage production can be increased and the soils protected by seeding disturbed areas to species such as orchardgrass, tall fescue, timothy, and white Dutch clover

\$101The important native understory forage plants on the Uvi soil are elk sedge, Columbia brome, bluegrass, and willow. This soil can produce forage for livestock and big game animals for 10 to 15 years after the tree canopy 15 opened. During this period, total annual production of air-dry forage will vary from 1,900 pounds per acre to less than 300 pounds per acre.

\$101The important native understory forage plants on the Vassar soil are elk sedge, Columbia brome, redstem ceanothus, willow, and rose. This soil can produce forage for livestock and big game animals for 5 to 10 years after the tree canopy is opened. During this period, total annual production of air-dry forage will vary from 2,400 pounds per acre to less than 50 pounds per acre.

\$101Management of the vegetation on this unit should be designed to encourage the regeneration of timber and to ensure that there is adequate litter to protect the soils. The very steep slopes limit the movement of livestock and the accessibility of forage.

\$IOIThis unit is poorly suited to recreational development. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope.

\$1017his unit is poorly suited to homesite development. The main limitation Is slope.

\$101This map unit is in capability subclass VIIe.

<sup>\*</sup>Computer Assisted Writing (CAW)'s are double spaced in manuscript form Only this example attachment is single spaced to conserve space.

### FIELD TRIP

### WESTERN REGIONAL TECHNICAL WORK PLANNING CONFERENCE

OF THE

NATIONAL COOPERATIVE SOIL SURVEY

**February 13,** 1980

SAN DIEGO. CALIFORNIA

		ACKNOWLEDGMENT	S		
W e	greatly appreciate	the work and a	ussistance of Geo	orge Borst,	

### FIELD TRIP

### WESTERN REGIONAL TECHNICAL WORK-PLANNING CONFERENCE FOR SOIL SURVEY

February 13, 1980 San Diego, California

8:00 A.M. Leave motel by Charter Bus

Observe terraces and terrace escarpments enroute to

stop 1 & 2. Review escarpments in San Clemente Canyon

before Stop 1 & 2.

Stops 1 & 2 Mound-Intermound Transects in the Miramar Mounds Registered

National Landmark--Miramar Naval Air Station.

Stop 3 Chesterton series north of intersection of Ruffner Street and Convoy Ct. in an exposed cut. Note the abrupt boundaries, nodules, duripan, and "windows" in the pan.

Box Lunch--Torrey Pines State Beach
12:00 noon
(approx.)

Stop 5 Torrey Pines State Reserve--Optional.

Discussion of soils and vegetation by Borst or a Park Resource

Ecologist

Clay Illuviation and Lamella Formation in Coastal Plain Terraces.

Coast Highway north of Leucadia. Notice filled valleys, sea

coast erosion, sand bars, terraces, stabilized dunes, and escarpments enroute to and from Stop 6.

stop 7
Overview of San Diego Area and Geomorphic Land forms from Mt.
Soledad--Optional.

4:30 P.M. Arrive at motel. (approx.)

The following information is excerpted from various publications, personal letters and memorandums, draft publications, and S.S.I.R. No. 24. For more information refer to list of references at the end of this report.

Stops 1 & 2 Miramar Mounds Registered National Landmark.

### Miramar Transects No. 1 & No. 2

The Miramar Mounds Registered National Landmark occurs on the Linda Vista Terrace that is underlain by the Poway conglomerate. Poway conglomerate is a large body of sand and gravel that was deposited in Eocene time by a major stream which once flowed west across the Peninsular Range. Most of the stone and gravel which occurs in this formation is foreign to this range, and the source of this material has been a source of intense speculation and study for a number of years. Lillegraven has recently traced these gravels to river which once flowed out of the mountains of Sonora, Mexico into Southern California and northern Baja California in Eocene time, prior to the creation of the rift valley occupied by the Gulf of California and the Imperial Valley. This finding provides a valuable guide to the amount of continental drift which has occurred in this area since the time of deposition of this formation. George Borst has presented a theory as to their origin as follows:

"They are of widespread occurrence in western United States, where they are also know as "pimple mounds" and "hogwallow microrelief." They closely resemble the mounds which occur in Australia, India, and elsewhere, which are known as gilgai. Where these occur on nearly level landscapes, small seasonal pools occur between the mounds during the wetseason; where these are absent on steeper slopes, the mounds are commonly oriented vertically, in the direction of the steepest slope.

"I believe that all of these mounds occur as a result of shrinking and swelling of clays in climates with strongly alternating wet and dry seasons. Thus, in California they are most strongly developed in those parts of the state where the alternation of wet and dry seasons is most extreme - in the Sacramento and San Joaquin valleys and the Southern California coastal plain, - and where mass movement in clay soils is therefore most extreme.

"The **sequence** of events which bring about the creation of these mounds, I believe is this:

- (1) Drying and cracking of clays in the subsoil during the dry season.
- (2) Sloughing of granular or coarse-textured material into such'cracks, either by mechanical disturbance of the surface soil during the dry season, or by water movement with heavy early rains, before the cracks have been closed by rewetting. Although this is a very slow process, which involves only a very small volume of soil, there is a gradual increase in the volume of the lower soil horizons, with increasing horizontal soil pressure in these horizons when the soil is wet. Careful examination of the soil along such cracks often will reveal some material resembling the surface soil in their lower part.
- (3) These pressures are ultimately relieved by upwelling of the soil in small mounds, which initially are only slightly differentiated and elevated above the surrounding soil.
- (4) Since these mounds are slightly higher and better drained and aerated, they tend to be occupied by more vigorous and deeper-rooted plants than the surrounding area.

- (5) Plant succession in these incipient mounds tends to deplete soil moisture more quickly, causing the soil to dry and shrink, so that the area of pressure relief progressively becomes more widespread as moisture is depleted from the mounds.
- (6) As the size and elevation of the mounds is increased, shear planes in the lower soil horizons are gradually extended and lower soil horizons are further uparched into the mound. Finally, a condition of equilibrium is attained between continued uplift and erosion of soil from the surface of the mound into the surrounding depressions.
- (7) Accompanying this process of uparching, the soil aggregates or "peds" around the periphery of the mounds become disoriented, and there is accelerated leaching and movement of clay from the surface into the subsoil horizons, bringing about the marked horizon differentiation characteristic of the mounds.

"Soil scientists and geologists in many parts of the world have advanced many ingenious theories as to the origin of these mounds. Among the ideas that have been advanced is that they are produced by pocket gophers, who establish their nests in the highest and best-drained locations, and by burrowing in the surrounding areas, move soil backward under their bodies in the direction of the mound (Arkley and Brown, Dalquist and Scheffer, Davis, Price); that they are produced by upwelling of groundwater from pressurized artesian aquifers (Nikiforoff); that they are old stabilized dunes, developed as hummocks around the base of shrubs during a period of great aridity and high wind (Shaw); that they are hummocks deposited around the base of shrubs by moving floodwaters (Gangmark and Sandford); and that they are Indian burial mounds (Wilkes). None of these theories would seem to account for all the features commonly associated with the mounds - especially their strongly differentiated soil horizons, the uparching of the subsoil in the mounds, the disorientation of subsoil aggregates in the periphery of the mounds, and the extensive shear planes or "slickensides" in their lower soil The theory of their formation by pocket gophers is probably the horizons. most widely held in California at the present time. There are many soils in this state and elsewhere which are intensively worked by burrowing animals. Such soils, however, have very deep, dark-colored, granular surface soils, weakly differentiated subsoil horizons, and numerous filled and partially filled animal burrows or "krotovinas" throughout. None of these features are commonly associated with the soils in mima mounds in California."

The Miramar Mounds Registered National Landmark is a parcel of about 400 acres of federal land which has been designated by the National Park Service for the preservation of the well developed mima mounds or gilgai and the associated vernal pools which occur between them. It contains a representative body of the complex of soils which have been identified with the Redding series, as well as the type location of this series in San Diego County. The Redding soils are presently classified as Abruptic Durixeralfs, fine, kaolinitic, thermic. Members of this complex are classified as:

Transect No. 1 37-1 Typic Durixeralf fine-loamy, mixed, thermic

37-2 Abruptic Durixeralf fine, mixed, thermic

37-3 Typic Durochrept coarse-loamy, mixed, thermic, shallow

Transect No. 2 37-4 Natric (ultic) Haploxeralf fine-loamy, mixed, thermic

37-5 Natric (ultic) Haploxeralf fine, mixed, thermic

A great deal **more** work needs to be done to establish the distribution and relationship of these soils. This Registered National Landmark has been established to preserve an undisturbed body of these soils for such study. These

soils have been described and sampled about half a mile north of this exposure at an elevation of about 430 feet.

# Miramar Transect No. 1

Transect No. 1 is located near the rim of Kearney Mesa along a branch of  $San\ Clemente$  canyon. The transect is 950 feet west and 750 feet north of the southeast corner of section 24, town 15 south, range 3 west.

SOIL FAMILY: Typic Durixeralf, fine-loamy, mixed, thermic
SOIL Mongerate loam SOIL Nos S66Calif-37-1 LOCATION San Diego County, California LAB. Nos. 66233 - 66235 SOIL SURVEY LABORATORY Riverside, California 1B1b Size class and particle diameter (mm: 3A1 fotel 1/ Copie Isagments142 a Sitt Very coarse (2-1) Medium Fine tet. 🎞 🗍 let. 🎞 Very fine Depth **>** 2 2 - 19 | 19 - 76 (0.05-0.002) (1-0.5) (0.5-0.25) (0.25-0.1) (0.1-0.05) 0.05-0.02 (0.02-0.02) (0.2-0.02 (2-0.05) < 0.002 (2-0 I) Pct of \_ Pct. of < 2 mm 49.6 35.4 15.0 2.3 13.7 16.5 12.2 4.9 16.7 18.7 26.3 44.7 46.8 34.9 18.3 1.8 11.5 15.4 12.7 5.4 15.5 19.4 26.5 41.4 46.1 32.9 21.0 2.4 11.8 15.0 11.7 5.2 14.4 18.5 24.7 40.9 4.9 16.7 18.7 4 3 4 13 0- 2 All 12 2-15 A12 15-33 3B2 4D1 641a 6Rla 6C2. 6Elb 8Cla 4Alf 4Alh 4Blc 4B2 Exten - Exten Ext. Depth Organic Kitrogen C/N Carbonat sibil- sibil-Trop Cm as CaCO<sub>3</sub> 1/3 Oven ity H<sub>2</sub>O as Fe ity dry bar bar bar COLET COLE 1:1 in./in. in./in. 0.013 0.011 Pct Pct Pc1 Pct. g/cc 2,01 1.66 1.73 0.91 13.3 6.4 2-15 0.85 1.51 1.58 0.93 12.4 6.5 0.016 0.015 5.3 1.60 1.67 7.6 0.015 0.014 15-33 0.56 0.92 13.5 4.4 Extractabre bases SB1a 6H2a Cation Exch. 6G1d Base saturation Capacity Ext. Capacity
Acid- 5Ala 5A3a 5C3 5C1 6N2. 602a 6P2a Sum Depth of KCI rio.i Ext. Sum Nt.OAc C# Mg Nø bases ity NH4OAc Sum Pct 1,0 12.3 16.1 66 86 5.5 3.3 0.5 10,6 4.2 11.5 14.6 0.1 71 90 2-15 5.8 3.8 0.5 0.3 10.4 60 80 6.4 12.0 16.0 15-33 3.9 8.0 0.3 9.6 0.8 Clay mineralogy (<0.002 mm.)7A From characterization sample (5Kg) (except as noted). 2/ 2-19 mm. from characterization sample, 19-76 mm. from field Mont. Verm. Mica Kaolin (in.) weight (>50 Kg). X-Tay

#### MONSERATE LOAM S66Calif-37-1

Location: San Diego County, California; Miramar Transect No. 1, station 23.8; 950 feet west and 750 feet north of the southeast corner of section 24, T. 15 S., R. 3 W. <u>Date of sampling</u>: June 10, 1966.

Description by: George Borst, David Estrada, Gerald Kester, Reuben Nelson, and Dennis Nettleton. Samples collected by: Klaus Flach, Benny Brasher, and Dennis Nettleton.

Classification: Typic Durixeralf; fine loamy, mixed, thermic family.

Vegetation: Sparse chamise and flattop buckwheat. Climate: Weather record for San Diego, near the sampling site, is mean winter air temperature 55° F., mean summer air temperature 68° F., mean annual precipitation 10 inches. Parent Material: Stream deposit over Pleistocene marine terrace. Topography: Flat marine terrace of less than I percent slope. Elevation: About 425 to 450 feet.

Drainage: Moderately well drained; runoff is medium; permeability is very alow. Soil Moiature: Drainage:

HORIZON	DESCRIPTION
A11 RSL No. 66233	0 to 2 inches, reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; abundant very fine roots; few very fine tubular pores; medium acid (pH 6.0); abrupt smooth boundary.
A12 <b>RSL No.</b> 66234	2 to 15 inches, reddish brown (5YR 5/4) loam, dark reddish brown (2.5YR 3/4) when moist; massive; hard, firm, sticky, very plastic; few fine to medium roots; many fine tubular pores; strongly acid (pH 5.5); many animal burrows and krotovinas, some approximately 3 inches in diameter are probably pocket gopher burrows, other approximately 3/8 inch in diameter are probably insect burrows; gradual wavy boundary.
<b>B1 R\$L</b> No. 66235	15 to 33 inches, reddish brown (5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) when moist; massive; hard, firm, very sticky, very plastic; few fine roots mostly in krotovinas; many fine tubular pores; very strongly acid (pH 4.5); common krotovinas filled with weakly granular material resembling the surface horizon; clear wavy boundary.
B2t	33 to 35 inches, reddish brown (2.5YR 5/4) heavy clay loam, dark reddish brown (2.5YR 3/4) when moist; weak medium • gular blocky structure; bard, firm, very sticky, very plastic; few fine roots; many fine tubular pores; common medium clay films line tubular pore.; very strongly acid (pH 4.5); very abrupt wavy boundary.
B3sim	3 5 inches+,

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE BOIL FAMILY: Abruptic Durixeralf, fine, mixed, thermic SOIL Nos S66Calif-37-2 LOCATION San Diego, California SOIL \_\_Redding losm (taxadiunct) LAB. Nos. \_\_\_\_66236 - 66242\* SOIL SURVEY LABORATORY Riverside, California 1815 Size class and particle diameter immi-1/ Coarse fragments 1A2 a Total Vary Sand Sitt Medium FIRE Van fine int III int 🏗 Depth Monzos Ciny Coarse 2-19 19-76 > Z coerse 12-1 (In.) (2-0.05) (0.05-0.002) (1-0.5) (0.8-0.25) (0.25-0.1) (0.1-0.05) (0.05-0.02) (0.02-0.02) (0.02-0.02) 55.3 18.0 13. 22 14 Al 33.5 11.2 9 52.8 35.9 11.3 3.1 12.9 17.1 13.8 5.9 15.7 20.7 27.0 46.9 14 5 4-15 A2 **B**1 35.3 27.3 37.4 1.6 8.3 11.2 10.0 4.2 11.1 16.2 19.4 31.1 0 37 8 15-18 18-30 B2t 24.2 15.6 1.0 6.0 6.7 2.9 6.9 8.7 12.6 21.3 0 60 6 2 30-36 B31eim 65.3 7.1 27.6 17.4 21.8 11.9 10.9 3.3 3.8 3.3 11.7 62.0 0 28 14 3 4 8.9 20.8 28.3 16.5, 15.1 3.6 2.4 14.7 80.7 0 9 20 Bm32sim 87.1 5.8 22.1 28.6 16.1 15.0 5.3 19 7.1 4.5 2.6 16.6 81.8 6 6Bla 6E15 Water conten 4D1 4D1 pн 6414 6C2a 3R2 ACT . 4Alf 4Alb 4Blc 4B2 xten - Exten-Ext. Nitrogen Depth Organic C/N sibil- sibil-(ln.) Iron Cm as CaCO. 1/3 Oven 15 ity ity as Fe H20 dry bar bar bar 1:1 Pet in./in. in./in. 5.5 0.009 0.008 Pc1 Pct g/tt g/cc Pet Pet 2.51 n- 4 1.30 0.88 4-15 0.63 1.65 1.68 0.91 9.8 3.7 0.006 0.006 5.5 15-18 0.41 1.59 1.78 0.95 20.3 12.1 0.039 0.037 18-30 0.38 1.47 1.78 0.96 26.8 20.6 0.067 0.065 4.3 30-36 0.35 1.69 | 1.77 0.91 17.0 15.8 0.015 0.013 4.3 36-45+ 27-41 11.2 0.005 0.004 0.17 1.79 1.81 0.86 1.92 1.94 0.85 8.0 0.004 0.003 4.4 Extractable bases \$1.4 6H2a Cation Exch 6Gld Water extract from salurated paste BA1 Ext. Capacity
Acid- 5Ala 5A3a 6N2 a Sum 6N1b 601b 6Pla 6Q1a 6Ila 6J1a 6Kla 6L1b 841. of KC1 Electrica (in.) Ca SG . HC0 5 C. Me bases ity NH4OAc S unto Ext. conductiv maq/100 mea-liter mmho:cm 11.1 0- 4 5.2 2.1 0.4 0.6 8.3 5.9 14.2 0.2 2.5 2.1 1.9 1.0 2.8 2.4 0.70 0.6 0.25 4-15 4.3 2.4 0.4 0.3 7.4 3.5 10.9 0.3 0.5 0.5 4.2 tr. 1.0 10.8 16.6 0.3 15-18 1.8 0,2 9.8 20.6 2.9 2.2 tr. 0.41 18-30 15.6 28.6 35.8 0.85 5.5 10.4 4.1 0.2 20.2 5.1 0.4 0.3 7.2 tr. 0.2 4.5 9.7 13.8 30-36 36-454 9.5 8.3 4.9 0.2 19.7 18.1 14.3 29.4 11.7 26.6 34.0 29.8 0.8 0.3 2.12 5.1 5.2 0.6 tr.

Depth	&A. Water	SD2 Exchange		miner 002 mm			Base set	oration 5C1
(in.)	at Saturation	obie Na	Mont.	Verm.	Mica	Keolin	Sum	NHLOAC
	Pet	Pct	s	<u> </u>	ay_	>	Pct	Pct
0-4	31.9	0.3					58	75
4-15	16.5	0.3	t	-	XX	×	68	100+
15-18	37.3	1.6					52	65
18-30	65.2	3.7	XX.	-	•	xxx	56	71
30-36	44.5	4.3	xx	- 1	-	жжж	58	67
36-45+	44.4	4.2					61	68
27-41	39.7	3.2	жх	-	-	x	56	64
					•			

0.2 12.7

9.8

19.8 22.5

3.7

 $\frac{4.7}{3.2}$ 

RSL 66242 was collected at station 39.8, or 6.8 feet from \$66Calif-37-2.

1/ From characterization sample (5 kg) (except as noted). 2/ 2-19 mm. from characterization sample, 19-76 mm. from field weight (>50 kg)...

3/ 2-19 mm. from characterization sample, 19-76 mm. from field weight; >2 mm. includes volume estimate of >76 mm. fraction.

- looked for but not found

t = trace

x = small

YY . moderate

abundant dominant XXXX

1.92

3.00

9.5

0.1 17.8 2/시작(제) 기자(기) 기사(기)

# REDDING LOAM (taxadjunct) 1/ S66Calif-37-2

Location: San Diero County, California: Miramar Transect No. 1, station 33.0: 950 feet west riac marine terrace of less than I percent stope. Elevation: About Drainage: Moderately well drained; runoff is medium; permeability is very slow. Soil Moisture: Dry. Remarks: Less than 15 percent rounded gravel throughout. HORIZON **DESCRIPTION** 0 to 4 inches, yellowish brown (10YR 5/6) loam, dark yellowish brown (10YR 4/6) when moist; A1 weak fine granular structure; slightly hard, very friable, nonsticky, nonplastic; abundant RSL No. 66236 very fine roots; many very fine tubular pores; medium acid (pH 5.8); clear smooth boundary. A2 4 to 15 inches, light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; massive; hard, RSL No. friable, slightly sticky, nonplastic; plentiful very fine to medium roots; many very fine on ped faces; very strongly acid (pH 4.5); very abrupt smooth boundary. 18 to 30 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; strong medium angular blocky structure; very hard, firm, sticky, plastic; plentiful very fine to fine roots; common very fine tubular pores; many thick clay skins.\* on ped faces; very strongly B2t RSL No. 66239 acid (pH 4.5); abrupt smooth boundary. 30 to 36 inches, yellowish red (5YR 5/6) duripan, yellowish red (5YR 4/6) when moist; strong fine angular blocky structure; indurated; few fine roots on ped exteriors; few fine B31sim RSL No. tubular pores; many moderately thick clay skins on ped faces; extremely acid (pH 4.2); 66240 abrupt smooth boundary. B32sim 36 to 45 inches +. light brownish gray (2.5Y 6/2) durinan, gravish brown (2.5Y 5/2) wher

- Probably mostly pressure faces --- some are slickensides.
- The Redding series is in a fine, kaolinitic, thermic family of Abruptic Durixeralfs. This pedon is in the same subgroup, but has about equal amounts of montmorillonite and kaolinite.

SOIL FAMILY: Typic Durochrept, coarse-loamy, mixed, thermic
SOIL Arlington loam (taxadjunct) SOIL Nos S66Calif-37-3 LOCATION San Diego County, California

\_ LAB Nos \_\_66243 - 66248 SOIL SURVEY LABORATORY Riverside, California 1315 Size class and particle diameter imm. 3A1 Send Silit 1/Coarse fragments1A2 a 
 Very coarse (2-1)
 Coarse (1-0.5)
 Medium (0.5-0.25)
 Fine (0.25-0.1)
 Very fine (0.1-0.05)
 Int. III (0.05-0.02)
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	Clay	pinera	logy (	<0.002	mm 37A		
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21-24 24-58+			-		!		66247 and a
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2-19 mm. from characterization sample, 19-76 mm. from field weight (>50 Kg).

3/ 2-19 mm. from characterization sample, 19-76 mm. from field weight; >2 mm. includes volume estimate of >76 mm. fraction.

4/ Calculation of % >2 mm. of these horizons differs from that of those above only in that a Bd 1/3 bar of 1.79 g./cc. was assumed for 66247 and a Bd 1/3 bar of 1.92 g./cc. was assumed for 66248.

= looked for but not found

- dominant

# ARLINGTON LOAM (taxadjunct) 1/ \$66Calif-37-3

Location: San Diego County, California; Miramar Transect No. 1, station 44.1; 950 feet west and 750 feet north of the southeast corner of section 24, T. 15 S., R. 3 W. <u>Date of sampling</u>: June 10, 1966.

marine terrace of less than 1 percent slope. Elevation: 425 to 450 feet. Drainage: Moderately well drained; runoff is medium; permeability is very slow. Soil Moisture: Dry.

Remarks: Very cobbly below 24 inches.

HORIZON	DESCRIPTION
All RSL No. 66243	O to 1 inch, grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak coarse platy structure; soft, friable, nonsticky, slightly plastic; abundant very fine roots; very strongly acid (pH 5.0); abrupt smooth boundary.
A12 RSL No. 66244	1 to 5 inches, strong brown (7.5YR 5/6) loam, dark yellowish red (5YR 4/6) when moist; massive; hard, friable, nonsticky, plastic; few very fine to medium roots; few very fine tubular pores; strongly acid (pH 5.5); abrupt smooth boundary.
A2 RSL No. 66245	5 to 10 inches, light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; massive; hard, friable, nonsticky, plastic; few very fine to medium roots; many very fine tubular pores; very strongly acid (pH 5.0); abrupt smooth boundary.
B1	10 to 11 inches, pink (7.5YR 7/4) loam, light brown (7.5YR 6/4) when moist; massive; hard, friable, slightly sticky, plastic; few very fine to medium roots; many very fine tubular pores; few thin colloid stains on mineral grains; very strongly acid (pH 4.6); abrupt wavy boundary.*
B2taim RSL No. 66246	11 to 21 inches, grayish brown (2.5Y 5/2) duripan, dark grayish brown (2.5Y 4/2) when moist with dark red (2.5YR 3/6) coatings of iron oxide and clay on cleavage planes; strong medium angular blocky structure; indurated; very few, very fine to fine roots; very strongly acid (pH 4.5); clear smooth boundary.
IIB31sim RSL No. 66247	21 to 24 inches, pale brown (10YR 6/3) gravelly duripan, brown (10YR 5/3) when moist; massive; indurated; very few fine roots; very strongly acid (pH 4.5); clear smooth boundary.
IIIB32sim RSL No. 66248	24 to 58 inches +, very cobbly duripan; massive; indurated, but somewhat weaker than above.

<sup>\*</sup> Strongly degraded at contact with underlying duripan.

The Arlington series is in a coarse-loamy, mixed, thermic family of Haplic Durixeralfs. This pedon has an indurated duripan. It also has clay skins and a clay increase sufficient for an argillic horizon in the duripan horizon. However, the classification system does not provide for horizons having properties of both argillic horizons and duripans.

The micromorphology of site 37-2 might help us infer the genesis of this strongly weathered soil.

Horizon and depth cm	B.S. sum of cations	Micromorphology
Al O-10	58	Intertextic structure. Skeleton grains are embedded in a porous groundmass. Plasm occurs as domains or islands within the groundmass. Most domains are <b>pseudomorphs</b> of biotite and hornblende. Some are pale green, weakly pleochroic, and may be chlorite.
<b>B1</b> 36-46	52	Intertextic structure. Skeleton grains are embedded in a porous groundmass. Mosepic plasmic fabric, i.e. the plasma occurs as domains or islands within the groundmass. Illuviation argillans or clay skins line the pores.
<b>B2t</b> 46-76	56	Porphyroskelic structure. Skeleton grains float in plasma. <b>Vo-skel-masepic</b> fabric, I.E. plasma is stress oriented.
<b>B31sim</b> 76-91	58	Porphyroskelic structure. Skeleton grains float in an isotic groundmass which has a few <b>skelmasepic</b> areas. The <b>groundmass</b> is brown in plain light but isotropic under crossed <b>nicols</b> . There are a few illuviation argillans. These are in pores which presumably do not swell shut.
<b>B32sim</b> 91-114	61	Porphyroskelic structure. Skeleton grains float in an isotic groundmass which has a few skelsepic areas in cracks or breaks in the duripan. Most pores have illuviation argillans. Some gypsum occurs in pores.
<b>B33si *</b> 150-700	78	Porphyroskelic structure. Skeleton grains float in an isotic <b>groundmass</b> which has a few skelsepic areas. There are illuviation argillans on some skeleton grains and in pores.
B34si * 700-800	80	Agglomeroplasmic structure. Spaces between skeleton grains are partly filled by isotropic plasma. The remainder of the plasma occurs as illuviation argillans in pores.
<b>Csi *</b> 800-1500	97	Agglomeroplasmic structure. Spaces between skeleton grains are partly filled by isotropic plasma.

<sup>\*</sup> Lower horizons were sampled in the San Clemente Canyon gravel pit about a mile southwest of the site.

In most years this soil becomes saturated **toat** least the top of the duripan. Weathering and translocation of weathering products, however, have extended to a depth of at least 15 meters. Both kaolinite and smectite occur in the upper few meters, but the proportion of smectite increases with increase in depth.

The Redding soils contain more smectite than the Chesterton soils. The dominance of smectite over kaolinite shows up in the CEC (48 meq/100 g) and the L.E. (6.7%). Smectite increases in relative amount over kaolinite with increase in depth. Diagnostic x-ray peaks of the smectite in the duripan are hroad and have low peak heights compared to patterns of the same clays following removal of the silica, but the silica does not prevent expansion of the clays to 18 A<sup>O</sup> upon Mg++ saturation and glycerol solvation. We were able to extract 6.2% Si from the finely ground B32sim horizon of Redding in 100 minutes using hot dilute (0.5N) NaOH (Flach, K. W., W. D. Nettleton, L. H. Gile, and J. G. Cady. 1969. Pedocementation: Induration by silica, carbonates, and sesquioxides in the quaternary. Soil Science 107: 442-453).

These observations suggest that kaolinite formed in the upper part of the soil during its early history while silica and bases were being leached to greater depth. The silica and bases accumulated and smectite formed below the solum. Part of the silica accumulated as a cement forming a duripan. The duripan developed **more** with time, eventually it greatly restricted movement of water and roots. Bases and silica then began to accumulate in the solum and smectite began to form.

Base saturation and the amount of weatherable minerals in the Redding soils are less than we have found in most soils of the Coastal Region of Southern California, but are more than those of Ultisols of the southeastern United States, or the Oxisols of Puerto Rico and Hawaii, for example. Their high degree of weathering and great depth are similar to those found in old soils of moister regions, but their salt content and silica cemented horizons are like those of soils in Riverside or San Bernardino Counties of California which also receive about 200 to 250mm of precipitation.

# Miramar Transect No. 2

Transect No. 2 is located on the Kearney Mesa more than one-half mile from San Clemente canyon. This east-west transect is 100 feet east and 50 feet north of the southwest corner of section 19, town 15 south, range 2 west. The transect is 38 feet long. It crosses one mound and an adjacent depression (see chart of Miramar Transect No. 2). The soils of this transect are somewhat less well drained than those of transect No. 1. A window occurs in the pan in this traverse also. It is 15 feet wide and is near the side of the mound. Here the trench extends to 98 inches. Again the top of the clayey Bt horizon and the top of the duripan below hold approximately level across the transect.

SOIL FAMILY: Natric Haploxeralf, fine-loamy, mixed, thermic.
SON Redding sapity loam (taxaifunct) SON Nos S66Calif-37-4 LOCATION San Diego County, California

SOIL SURVEY LABORATORY Riverside, Celifornis LAB Nos. 66250 - 6625E

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		602a	6P2a	6Q2#	of	Ext. Acid-	Capa 5Ala	SA34	KC1			6Pla	6Q1a	6Ila	6J1a	6Kla		Electroca -
Depth (in.)	6N2 4				I - 3	Ext. Acid-	Capa	5A34	KC1 Ext.	6N1b Ca	601b	<del></del>						
		602a	6P2a	6Q2#	of bases	Ext. Acid-	Capa 5Ala	5A34	KC1			6Pla	6Qla	cc3	6J1a	6Kla		Electrica- conduction its
		602a	6P2a	6Q2#	of	Ext. Acid-	Capa 5Ala	5A34	KC1 Ext.			6Pla	6Qla	6Ila	6J1a	6Kla		Electrica - Conduction
(in.)	Ca	602a Mg	6P2a	6Q2#	of bases meq:100 g	Ext. Acid- ity 5.0 1.3	Capa 5A1a NH <sub>4</sub> OAc 7.9 3.0	SA34 Sum	KC1 Ext.	3	ME	6Plæ	6Qla k	cc3	6J14 HCO <sub>3</sub>	6Kla Ci		Electrica conduction its mmno vm
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0- 4 4-10 10-17 17-30	3.6 1.2 1.9 2.4	0.9 0.8 3.3	0.2 0.3 0.8 2.4	6Q2a K 0.4 0.1 0.2 0.2	of bases msq:100 g 5.1 2.4 6.2 9.9	5.0 1.3 4.9	7.9 3.0 9.6 12.2	5A34 Sum 10.1 3.7 11.1 15.0	KC1 Ext. A1***	2.4 1.0 0.4 1.0	1.6 0.4 0.3 2.2	1.0 3.0 3.8 19.4	meq'1 0.4 0.1 tr.	cc3	2.4 1.0 0.4 0.2	1.5 1.0 1.0 17.3		Electrica- conduction (f) mmnc .m 0.52 0.39 0.33 2.43
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0- 4 4-10 10-17 17-30 30-36 36-45 45-49	3.6 1.2 1.9 2.4 2.9	0.9 0.8 3.3 4.9 6.5	0.2 0.3 0.8 2.4 4.7	0.4 0.1 0.2 0.2	of bases 5.1 2.4 6.2 9.9 14.3	5.0 1.3 4.9 5.1 6.8	7.9 3.0 9.6 12.2 14.9 27.9	5A34 Sum 10.1 3.7 11.1 15.0 21.1	C1 Ext. A1+++ 0.2 0.1 1.3 0.9 0.7	2.4 1.0 0.4 1.0 4.5	1.6 0.4 0.3 2.2	1.0 3.0 3.8 19.4 53.0	6Q1a k mq1 0.4 0.1 tr. 0.1 0.2	cc <sub>3</sub>	2.4 1.0 0.4 0.2 0.4 1.9	1.5 1.0 1.0 17.3 61.6	sc <sub>4</sub>	mmnc .m 0,52 0,39 0,33 2,43 6,2 8,2
0- 4 4-10 10-17 17-30 30-36 36-45 45-49	3.6 1.2 1.9 2.4 2.9 5.6	0.9 0.8 3.3 4.9 6.5 5.9	0.2 0.3 0.8 2.4 4.7 7.9	0.4 0.1 0.2 0.2 0.3 0.3	of bases 5.1 2.4 6.2 9.9 14.3 19.7 23.1	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9	7.9 3.0 9.6 12.2 14.9 27.9 35.2	5A34 Sum 10.1 3.7 11.1 15.0 21.1 28.7 33.5	KC1 Ext. A1+++ 0.2 0.1 1.3 0.9 0.7 1.1	2.4 1.0 0.4 1.0 4.5 7.4	1.6 0.4 0.3 2.2 11.6 20.4 23.2	1.0 3.0 3.8 19.4 53.0 69.0 86.5	meq': 0.4 0.1 tr. 0.1 0.2 0.3	6Ila cc3 iter	6J1a HCC3 2.4 1.0 0.4 0.2 0.4 1.9 0.6	1.5 1.0 1.0 17.3 61.6 85.9	10.6 11.6	mmns m 0.52 0.39 0.33 2.43 6.2 8.2
0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59	3.6 1.2 1.9 2.4 2.9 5.6 5.9	0.9 0.8 3.3 4.9 6.5 5.9	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2	0.4 0.1 0.2 0.2 0.3 0.3 0.3	of bases 5.1 2.4 6.2 9.9 14.3 19.7 23.1 21.5	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9	7.9 3.0 9.6 12.2 14.9 27.9 35.2 28.7	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4	KC1 Ext. A1 <sup>+++</sup> 0.2 0.1 1.3 0.9 0.7 1.1 1.5 2.2	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5	meq': 0.4 0.1 tr. 0.1 0.2 0.3	6Ila cc3 iter	6J1a MCC3 2.4 1.0 0.4 0.2 0.4 1.9 0.6 0.7	1.5 1.0 1.0 17.3 61.6 85.9 103 51.8	10.6 11.6	mmnc .m 0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67
0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59	3.6 1.2 1.9 2.4 2.9 5.6 5.9	0.9 0.8 3.3 4.9 6.5 5.9	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2	0.4 0.1 0.2 0.2 0.3 0.3 0.3	of bases 5.1 2.4 6.2 9.9 14.3 19.7 23.1 21.5	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9	7.9 3.0 9.6 12.2 14.9 27.9 35.2 28.7	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4	KC1 Ext. A1 <sup>+++</sup> 0.2 0.1 1.3 0.9 0.7 1.1 1.5 2.2	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5	meq': 0.4 0.1 tr. 0.1 0.2 0.3	6Ila cc3 iter	6J1a MCC3 2.4 1.0 0.4 0.2 0.4 1.9 0.6 0.7	1.5 1.0 1.0 17.3 61.6 85.9 103 51.8	10.6 11.6	mmnc .m 0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67
0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59	3.6 1.2 1.9 2.4 2.9 5.6 5.9	0.9 0.8 3.3 4.9 6.5 5.9	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2 6,6	0.4 0.1 0.2 0.2 0.2 0.3 0.3 0.2	of bases 5.1 2.4 6.2 9.9 14.3 19.7 23.1 21.5 21.2	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9 8.1	7.9 3.0 9.6 12.2 14.9 27.9 35.2 28.7	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4 29.3	KC1 Ext. A1 <sup>+++</sup> 0.2 0.1 1.3 0.9 0.7 1.1 1.5 2.2 2.2	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1 1.6	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7 3.7	1.0 3.0 3.8 19.4 53.0 69.0 86.5 39.4	meq:1 0.4 0.1 tr. 0.1 0.2 0.3 0.3	6Ila   cc3   lter -	2.4 1.0 0.4 0.2 0.4 1.9 0.6 0.7	1.5 1.0 1.0 17.3 61.6 85.9 103 51.8 37.4	10.6 11.6 8.8	mmnc m 0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67 4.68
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0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59 59-72	3.6 1.2 1.9 2.4 2.9 5.6 5.9 4.3 4.2	0.9 0.8 3.3 4.9 6.5 5.9 6.6 9.8 10.2	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2 6,6	0.4 0.1 0.2 0.2 0.3 0.3 0.2 0.2	of bases 5.1 2.4 6.2 9.9 14.3 19.7 23.1 21.5 21.2	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9 8.1	7.9 3.0 9.6 12.2 14.9 27.9 35.2 28.7 25.4	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4 29.3	KC1 Ext. A1+++ 0.2 0.1 1.3 0.9 0.7 1.1 1.5 2.2 2.2	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1 1.6	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7 3.7	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5 39.4	med: 0.4 0.1 tr. 0.1 0.2 0.3 0.3 0.2 0.2	6Ila   cc3   lter -	6J14 HCC3 2.4 1.0 0.4 0.2 0.4 1.9 0.6 0.7	1.5; 1.0; 1.0; 17.3; 61.6; 85.9; 103; 51.8; 37.4;	10.6 11.6 8.8	mmnc m 0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67 4.68
0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59 59-72	3.6 1.2 1.9 2.4 2.9 5.6 5.9 4.3 4.2	0.9 0.8 3.3 4.9 6.5 5.9 6.6 9.8 10.2	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2 6,6	0.4 0.1 0.2 0.2 0.3 0.3 0.2 0.2	of bases 5.1 2.4 6.2 9.9 14.3 19.7 23.1 21.5 21.2	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9 8.1	7.9 3.0 9.6 12.2 14.9 27.9 35.2 28.7 25.4	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4 29.3	KC1 Ext. A1 <sup>+++</sup> 0.2 0.1 1.3 0.9 0.7 1.1 1.5 2.2 2.2	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1 1.6	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7 3.7	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5 39.4	6Q1a x 0.4 0.1 tr. 0.1 0.2 0.3 0.2 0.2	ttion	6J14 MCC; 2.4 1.0 0.4 0.2 0.4 1.9 0.6 0.7 0.7 kg)(ex	1.5 1.0 1.0 17.3 61.6 85.9 103 51.8 37.4	10.6 11.6 8.8	0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67 4.68
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0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59 59-72 Depth (In.) 0- 4 4-10 10-17 17-30 30-36 36-45 45-49	3.6 1.2 1.9 2.4 2.9 5.6 5.9 4.3 4.2 88A Water 30.8 12.4 21.4 31.3 39.8 66.7 50.7	602a Mg 0.9 0.8 3.3 4.9 6.5 5.9 6.6 9.8 10.2  502 Eschange able Na Pct 2.5 10.0 7.3 14.8 17.0	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2 6.6 Mont.	0.4 0.1 0.2 0.2 0.3 0.3 0.3 0.2 0.2	of bases mw.100 s 5.1 2.4 6.2 9.9 14.3 19.7 23.1 21.5 21.2 ralogy m.) 7A Mica	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9 8.1	Capa 5A1a NH4, QAc 7.9 3.0 9.6 12.2 14.9 35.2 26.7 25.4 Base satt 5C3 Sum 9ct 50 65 66 68 69 69	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4 29.3 5C1 NL/OAC	KC1 Ext. A1+++ 0.1 1.3 0.9 0.7 1.1 1.5 2.2 2.2 2.2 3/ 2-1 fr 4/ Call	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1 1.6	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7 3.7  racter from each from each from from from from from from from from	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5 39.4	oci 1 0.4 0.1 tr. 0.1 0.2 0.3 0.3 0.2 0.2 0.2 0.2 derizating.	iter  le (5) tion so udes vo	6J14 HCC; 2.4 1.0 0,4 0.2 0.4 1.9 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.8 mple, olume 6258 d	1.5 1.0 1.0 1.0 17.3 61.6 85.9 103 51.8 37.4	10.6 11.6 8.8 s note	0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67 4.68
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A1+++ 0.1 1.3 0.9 0.7 1.1 1.5 2.2 2.2 2.2 3/ 2-1 fr 4/ Ca1 th	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1 1.6  model trace small model model model model model model model	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7 3.7 3.7 seight from eight; ion of izons and in the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5 39.4	oci 1 0.4 0.1 tr. 0.1 0.2 0.3 0.3 0.2 0.2 0.2 0.2 derizating.	iter  le (5) tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so t	6J14 HCC; 2.4 1.0 0,4 0.2 0.4 1.9 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.8 mple, olume 6258 d	1.5 1.0 1.0 1.0 17.3 61.6 85.9 103 51.8 37.4	10.6 11.6 8.8 s note	0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67 4.68
0- 4 4-10 10-17 17-30 30-36 36-45 45-49 49-59 59-72 0- 4 10-17 17-30 30-36 36-45 45-49	3.6 1.2 1.9 2.4 2.9 5.6 5.9 4.3 4.2 8A Water sturation Pet 30.8 12.4 31.3 39.8 66.7 41.7	0.9 0.8 3.3 4.9 6.5 5.9 6.6 9.8 10.2 5D2 Exchange abit Na Pct 2.5 10.0 7.3 14.8 17.4 11.8 17.0	0.2 0.3 0.8 2.4 4.7 7.9 10.3 7.2 6,6	0.4 0.1 0.2 0.2 0.2 0.3 0.3 0.3 0.2 0.2	of bases muq.100 g 5.1 2.4 6.2 9.9 14.3 19.7 23.1.5 21.2 ralogy m.) 7A Mica	5.0 1.3 4.9 5.1 6.8 9.0 10.4 7.9 8.1	7.9 3.0 9.6 12.2 14.9 27.9 35.2 28.7 25.4  Base sate 50 65 66 68 69 73	10.1 3.7 11.1 15.0 21.1 28.7 33.5 29.4 29.3	KC1 Ext. A1+++ 0.2 0.1 1.3 0.9 0.7 1.1 1.5 2.2 2.2 2.2 2.2 4/ Cal	2.4 1.0 0.4 1.0 4.5 7.4 8.9 3.1 1.6  model trace small model model model model model model model	1.6 0.4 0.3 2.2 11.6 20.4 23.2 5.7 3.7 3.7 seight from eight; ion of izons and in the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval of the interval	1.0 3.0 3.8 19.4 53.0 69.0 86.5 52.5 39.4	oci 1 0.4 0.1 tr. 0.1 0.2 0.3 0.3 0.2 0.2 0.2 0.2 derizating.	iter  le (5) tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so tion so t	6J14 HCC; 2.4 1.0 0,4 0.2 0.4 1.9 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.8 mple, olume 6258 d	1.5 1.0 1.0 1.0 17.3 61.6 85.9 103 51.8 37.4	10.6 11.6 8.8 s note	0.52 0.39 0.33 2.43 6.2 8.2 10.3 5.67 4.68

## REDDING SANDY LOAM (taxadjunct) 1/ S66Calif-37-4

Location: San Diego County, California; Miramar Transect No. 2, station 9.0; 100 feet east and 50 feet north of the southwest corner of section 19, T. 15 S., R. 2 W. Date of sampling: June 14, 1966.

Description by: George Borst, Roy Bowman, David Estrada, and Gerald Kester. Samples collected by: Leo Klameth and Dennis Nettleton.

Classification: Natria Haploxeralf, fine-loamy, mixed, thermic.

Vegetation: Sparse chamise and flattop buckwheat. Climate: Weather record for San Diego, near the

sampling site is mean winter sir temperature 55° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summer sir temperature 68° F. mean summe precipitation 10 inches. Parent Material: Stream deposit over Pleistocene marine terrace. Topography: Flat marine terrace of less than 1 percent slope. Elevation: About 425 to 450 feet. Drainage: Moderately well drained; runoff is medium; permeability is very slow. Soil Moisture: Dry.

#### HORIZON DESCRIPTION

0 to 4 inches, yellowish brown (10YR 5/4) sandy loam, brown to dark brown (10YR 4/3) when moist; weak fine granular structure; loose, very friable, slightly sticky, nonplastic; RSL No. 66250 plentiful fine and medium roots; many very fine interstitial and common fine tubular pores; strongly acid (pH 5.3); abrupt smooth boundary.

A2 4 to 10 inches, light gray (10YR 7/2) fine sandy loam, brown (10YR 5/3) when moist; weak RSL No. medium subangular blocky structure; slightly hard, friable, slightly sticky, nonplastic; 66251 few fine to medium roots; common very fine and fine tubular pores; strongly acid (pH 5.3); abrupt smooth boundary.

10 to 17 inches, brown (7.5YR 5/4) sandy clay losm, brown to dark brown (7.5YR 4/4) when RII RSL No. 66252

B12 moist; moderate medium angular blocky structure; hard, friable, sticky, slightly plastic; RSL No. very few fine roots; few very fine and fine tubular pores; common thin clay skins in 66253 pores; very strongly acid (pH 4.5); gradual smooth lower boundary.

30 to 36 inches, brown to dark brown (7.5YR 4/4) heavy clay loam, brown to dark brown **B13** RSL No. (7.5YR 4/2) when moist; moderate medium angular blocky structure; hard, friable, sticky, plastic; very few fine roots; few very fine and fine tubular pores; common thin clay 662% skins in pores; very strongly acid (pH 4.5); abrupt smooth boundary.

36 to 45 inches, brown to dark brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; strong medium to coarse angular blocky structure; very hard, firm, sticky, plastic; very B2t RSL No. few fine roots; many fine interstitial and very few fine tubular pores; extremely acid 66255 (pH 4,2); abrupt wavy boundary.

45 to 49 inches, grayish brown (10YR 5/2) ped exteriors and brown to dark brown (7.5YR 4/2) B31aim ped interiors both of which are of clay texture and dark gray (10YR 4/1) and brown to dark RSL No. brown (7.5YR 4/2) when moist; moderate medium to coarse angular blocky structure; hard 66256 to extremely hard, firm to extremely firm, sticky, plastic; very few fine roots; very few fine tubular pores; many thin to moderately thick clay skins on ped faces and in pores; extremely acid (pH 4.2); abrupt irregular boundary.

49 to 59 inches, grayish brown (10YR 5/2) ped exteriors and dark brown (7.5YR 3/2) ped B32sim interiors of clay texture, dark gray (10YR 4/1) and dark brown (7.5YR 3/2) respectively RSL NO. when moist; moderate coarse platy structure; strongly indurated ped interiors; very few 66257 fine roots; very few fine tubular pores; common thick clay skins on ped faces; clear smooth boundary.

IIB33sim 59 to 72 inches +, color pattern same as the B32sim; massive; weakly indurated; very common fine interstitial pores; common moderately thick clay skins on ped faces; RSI. No. approximately 30 percent cobbles. 66258

<sup>1/</sup> The Redding series is in a fine, kaolinitic, thermic family of Abruptic Durixeralfs. This pedon has an argillic horizon with less than 35 percent clay. It also has an exchangeable sodium percentage of more than 15 and a base saturation of less than 75 percent in the horizon, but no Natric Ultic subgroup has been provided for in the classification system.

SOIL FAMILY: Hatric Haploxeralf, fine, mixed, thermic SOIL San Miguel sandy loam varient SOIL Nos. S66Callf-37-5 LOCATION -San Diego County, California 66259 - 66260 SOIL SURVEY LABORATORY Riverside, California \_ LAB Nos. \_ 1B1b Total Size class and particle diameter imm 3A1 1/ Coarse fragments LA2 a lot 🏗 \$alt Fine int 🎵 Yen Very fine Sand Clay Coarse Medium 2 - 19 | 19 - 76 Deptr. coarse (2-1) 1)-0 5) (0.5-0.25) (0.25-0.1)(0 1-0.05) (0.05-0.02) (0.02- (0.2-0.02) (7-6.1) (2-0.05) (0.05-0.002) < 0.002<sub>3</sub> 35-45 7.7 9.0 7.9 9.7 3.6 1C.8 15.3 18.C 22.2 2/ 2/ 25.8 26.1 48.1 C. 9 4.6 0 **B22t** 1.0 4.8 4.0 12.0 16.3 19.7 23.4 45-57 27.4 28.3 44.3 4D1 6E1b 641. 6B1a 6C2a 8Cla 4Alf 4Alh 4B1c 4B2 Exten-Exten Ext. Organic Nitrogen C/N Depth sibil sibil-Iron Cm as CaCO<sub>3</sub> 1/3 15 1/3 Oven as Pe ity ity H<sub>2</sub>O bar bar bar dry COLET 1:1 Pct in/in. in./in.
16.8 0.047 0.046 Pct Pct Pc1 g/cc Pct. 4.2 22.5 0.35 1.62 1.86 0.98 35-45 16.8 0.052 0.051 4.1 0.98 24.5 1.54 1.79 Extractable bases 581a 6H2a Cation Exch 6G1d Base saturation Ext. Capacity
Acid- SAla SA3a 503 501 Sum 1940kc 602a | 6P2a 6N2.4 Sumo Depth of KC1 (In.) ity NH4OAc Sum Ext. ĸ Ce Mg bases 1.2 8.5 22.7 24.3 65 35-45 0.3 15.8 73 45-57 4.8 8.0 0.2 17.6 8.5 24.2 26.1 1.1 4.6 1/ From characterization sample (5Kg)(except as noted).
2/ 2-19 mm. from characterization sample, 19-76 mm. from field weight Clay mineralogy (<0.002 mm.)7A Depth Verm. Mics Kaolin (>50 Kg). - looked for but not found 35-45 t = trace ХX x small XXX xx = moderate xxx = abundant dominant

# SAN MIGUEL SANDY LOAM variant 1/

Location: San Diego County, California; Miramar Transect No. 2, station 21.1; 100 feet east and 50 feet north of the southwest corner of section 19, T. 15 S., R. 2 W. <u>Date of sampling</u>: June 14, 1966.

Description by: George Borst, Roy Bowman, David Estrada, and Gerald Kester. Samples collected by: Leo Klameth and Dennis Nettleton.

Classification: Natric Haploxeralf; fine. mixed, thermic family.

Vegetation: Sparse chamise and flattop buckwheat. Climate: Weather record for San Diego, near the sampling site, is mea" winter air temperature 55" F., mean summer air temperature 68°F., Mi" annual precipitation 10 inches. Parent Material: Stream deposit over Pleistocene marine terrace.

Topography: Flat marine terrace of less than 1 percent slope. Elevation: About 425 to 450 feet.

Drainage:

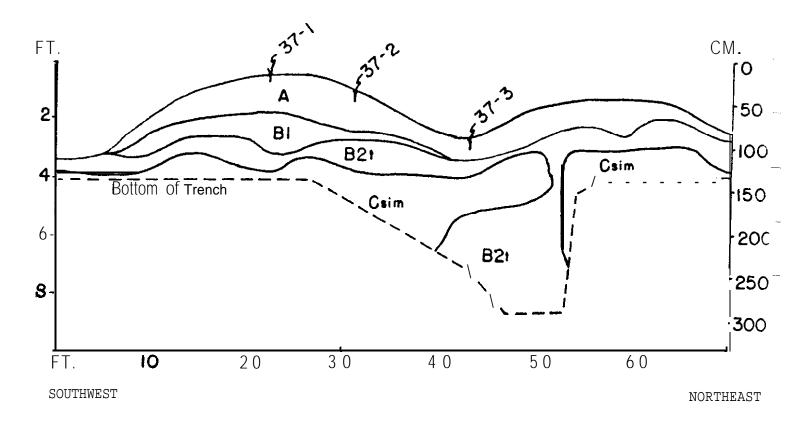
HORIZON

DESCRIPTION

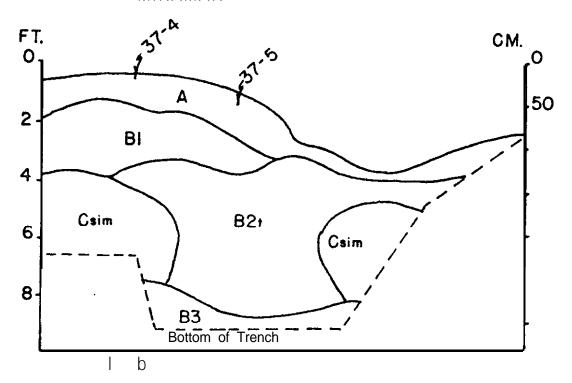
Al

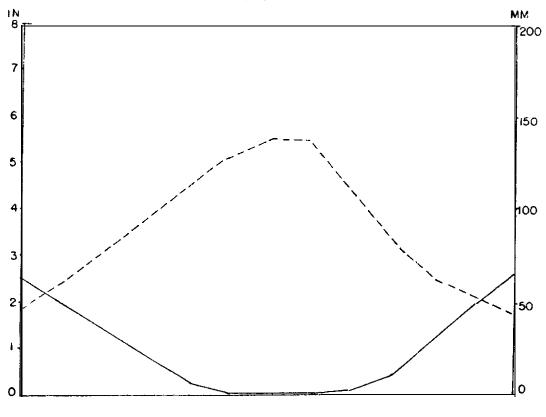
<sup>1/</sup> The San Miguel series is in a fine, montmorillonitic, thermic family of Typic Natrixeralfs. This pedon lacks a horizon with prismatic structure or blocky structure with tongues of an eluvial horizon with uncoated silt or sand grains extending more than 2.5 cm. into it. The horizon does have an exchangeable sodium percentage of more than 15 and a base saturation of less than 75 percent, but no Natric Ultic subgroup has been provided for in the system.

# MIRAMAR TRANSECT NO. I



MIRAMAR TRANSECT NO. 2





# MIRAMAR TRANSFOT NO. 1 8660ellf-37-2

\_ PRECIP. \_\_\_\_ P. E.

Her.	Depth	Hed./Total Sand	Clay		Sum of Bases*
A2	0-4in.	32.5%	11.2%	0.4 e.	3
<b>≜</b> 2	4-15	32.3	11.3	0.4	7.4
Bl	15-18	31.7	37.4	1.6	10.8
B2t	18-30	31.h	60.2	4.1	20.2
•	mea./10	0c.			

# MIRAMAR TRANSECT No. 2 866Callf-37-4

Hor.	Depth Fi	ne/fotal Band	Clay	Exch.	Sum of Bases
<b>A1</b>	0-41n.	33.2%	5.3%	0.2	5.1
<b>≜</b> 2	4-10	<b>3</b> 4.3	4.9	0.3	2.4
Bll	10-17	34.5	17.8	8.0	6.2
<b>3</b> 12	17-30	34.9	24.1	2.4	9.9
<b>B</b> 13	30-36	35.3	28.6	4.7	14.3
B2t	36-45	30.9	51.6	7.9	19.7
	_		_		

17

meq./100g.

20

# Stop 3 Chesterton Series

Some excerpts and tables from a manuscript by Torrent et al. on "Genesis of Some Typic Durixeralfs of Southern California" are included below.

Soils with a duripan are to be expected on old surfaces in an arid or semiarid environment. Soils in this kind of an environment but having evidence of wetness, including iron-manganese nodules and a gleyed horizon, occur in southern California. These remarkable soils have a complex origin.

One such soil in the Chester-ton series, a Typic Durixeralf, (Bowman, 1973; Soil Survey Staff, 1975) was studied on the coastal plain of California near San Diego. The soil developed on a gently rolling, eolian sand ridge. This ridge has lenses of marine gravel at its base and may be as old as early Pleistocene (Emery, 1950; Carter, 1957; Kennedy, et al., 1975; and Peterson and Kennedy, 1976). It is superimposed on an old wave-cut marine terrace that is 50 to 150 meters above present sea level.

Natural vegetation in the recent Quaternary may have been a forest of Torrey pine (Pinus torreyana), a rare species that is preserved in only two small areas of the California coast. Torrey Pin&State Park, about 11 km northwest of the study area, is one of the areas. Apparently, fire and the shift to the present dry climate have caused almost complete disappearance of the species. The present vegetation is dominated by chaparral shrubs, mostly chamise (Adenostoma fasciculatum), black sage (Salvia mellifera), laurel sumac (Rhus laurina), sugar bush (R. ovata), and California buck-wheat (Eriogonum fasciculatum). The understory is annual grasses and forbs.

The Typic Durixeralf we have examined apparently first weathered deeply under a warm, humid climate more like that of Santa Cruz, California, today. This weathering produced moderate amounts of clay down to depths of several meters. The clay, though not necessarily translocated appreciably is nonetheless reorganized into well oriented argillans. A duripan formed later with the onset of a drier climate, fossilizing the former profile up to a shallow depth. Horizons above the duripan were further weathered under a more humid climate, thus, creating a clear mineralogical break. This weathering was followed or accompanied by a relatively intense illuvial process that developed a B2 horizon on top of the duripan and produced hydromorphic conditions in the horizons above the duripan. The weathering was accelerated by the addition of laterally moving water from above the duripan of the higher lying Carlsbad soils. The hydromorphic conditions are no longer very pronounced under the present day dry climate, and the morphology of the Fe-Mn nodules suggests that they are relict features.

TABLE 1 - Selected morphological properties of the Chesterton soil

Horizon	Depth, cm	Color	Texture	Structure <sup>‡</sup>	Consistency	Roots	Other	Boundary -
Al en	0-15	5YR 3/3 7.5YR 4/4 (dry)	10	Moctve	S. hard Friable	Frequent Very fine	15% nodule Fe-Mn	K.W.
A2cn	15-32	5YR 3/4 7.5YR 6/6 (dry)	1 8	Massive	S. hard Friable	Frequent Very fine	25% nodule Fe-Mn	c.w.
B21t	32-52	2.5YR 3/4 2.5YR 3/6 (mottles)* 5YR 4/6 (dry)	βÌ	Mnssi <b>ve</b>	Hord Friable	Freq. to fine Very fine	< 1% nodule Fe-Mn	c.w.
B22tg	52-76	7.54r 4/4 (40%) 2.54 5/2 (40%) 2.54r 3/6 (20%)	scl.	Mяssive	V. bard Firm Sticky , plastic	Freq. to few Very fine	Slickenside at bottom horizon	8.1
B3ltsim	76-101	5YR 4/6 2.5YR 3/6 (mottles) 2.5Y 6/2	sl	Massive	V. hard to e. hard (gray areas) v. fire to e. firm (gray areas)		Silica tubules and seams. 2.5" 6/2 Bridge argillans	g.w. -
B32tsim	101-152	57R 5/6 2.5 YR 3/6 2.5Y 6/2	εl	Massive	As above	As above	As above	ð. –
B33teim	152+210	2.5YR 3/6 5YR 4/4 2.5Y 6/2	10	Massive	V. hard Firm to v. firm & e. firm (tubules)	As above	As above	g.v. -
B3 <sup>j</sup> +teim	210-296	2.5YR 3/6 10YR 6/2	rl	Maceive	An above	An above	Ar above	£.¥.
B35teim	296-366	2.5YR 3/6 10YR 8/3	l.e	Massive	As above	As above	Silica tubules	3.
B36tsi+	366-466	7.5YR 5/6 10YR 8/3	18	Massi <b>v</b> e	Hard to v. hurd, m. firm to e. firm		Silica tubules 107R 8/3	g• _
C1 +:	466-520	2.5YR 3/6 10YR 8/3	15	Massive	Hard M. firm		Silica tubules (few 107R 8/3	) g.
C5+	520-580	2.5YR 3/4 10YR 8/3	3 e	Massive	As above		Ar above	

<sup>\*</sup> Broken soft nodules

<sup>+</sup> Auger

<sup>\*</sup> We described the profile in winter when it was moist down to the durinan.

Bowman (1973) describes the A2cn as massive, but the other horizons above the durinan he describes as having structure.

PABLE 2 - Selected physical properties of the Chesterton soil

				Size	, Class	and Pa	rticle 1	Diamete	r				Te	xtural 1	Relations				er Conten		L.E
Harizon	Depth, cm	Tota Sand 2	Silt	Clay LT	VCS 2	CS 1	MS .5	FS .25	VFS .10	CSI .05	FSI .02	>2 mm % Whole	CS FS	Silt Sand	Fine Clay (< .0002) Total Clay	Eu: Len 1/3- Bar	ik city (CD)	1/3-Bar	15-Bar	1/3-Ear to 15-Bar	
		.05	.002	.002	1	% < 2		.10	.05	.02	.002	Soll				g/cc	g/cc	%	96	can/can	%
Alen Alen	<b>o-15</b> 15 <b>-3</b> 2	77. 5 79. 3	15.7 14.1	6. 8 6. 0	0. 2 0. 2	17. 7 17. 2	29. 6 30. 0	24. 5 27. 2		8. 4 7. 0	7. 3 7. 1	18.0* 26.5*	0. 72 0. 63	0,20 <b>0.18</b>	32.4 46.3	1. 71 nå	1.73 nd	<b>7.2</b> nd	2. 6 2. 7	.071 nđ	<b>0.3</b> nđ
521 <b>t</b> -12 <b>tg</b>	32-52 52-76	76.6 62.8	11.1 6.8	12.3 30.4	0.2 0.5	18.9 21.9	28.5 23.6	24.3 14.1		6.0 4.5	5.1 2.3	:	0.78 1.55	0.14	62.3 86.8	1.80	1.85 1.93	9.5 19.3	4.6 13.1	.074 .086	0.8 3.3
331tsim 32tsim	76-101 101-152	80.4 78.3	4.4 3-3	15.2 18.4	o.6 -	22.0 20.8	25.8 32.9	30.3 23.7	1.7	3.2 3.0	1.2	- -	0.73 0.88	0.05	90.1 88.8	nd 1.93	nd 1.98	nd 8.0	5-3 6.5	nd .027	nd 0.8
-33tsim j⇒tsim	•	86. 0 79. 4	2. 4 3. 5	<b>11.6</b> 16.9	0.1 <b>0.2</b>	<b>25.0</b> 25.4	41.3 39.7	18.8 12.8		1. 6 0. 6	0. 8 2. 9	-	1 33 1.98	0.03 0.04	90. 3 90. 1	nđ nđ	nd nd	nd nd	5. 5 7. 2	nd nd	nd nd
-35tsim -30tsi	296-366 366-466	84. 3 05. 4	<b>3.8</b> 2.8	11.6 11.8	0.1 0.1	<b>26.2</b> 28.5	39.8 39.3	16. 0 16. 7		1. 0 2. 8	2.8	-	1. 56 1. 71	0. 05 0. 03	91. 1 94. 0	1.58 nd	1.64 nd	<b>12. 1</b> nd	6. 4 5. 7	.089 nd	<b>1.:</b> nd
C1 C2	466-520 520-580	85. 3 74. 9	4. 3 13. 1	10.4 12.0	0.1 <b>0.6</b>	22.6 <b>21.2</b>	38. 2 27. 3	21.6 <b>19.2</b>		3. 4 8. 3	0. 9 4. 8	-	1. 05 1. 10	0. 05 0. 17	81. 0 68. 9	nđ <b>ad</b>	nd nd	nđ nđ	6. 5 6. 1	nd nd	nd nd

Fe-Mn nodules

b

About 5.4 cm of water are available for wetting the Chesterton pedon in February the wettest month (Table 7). 5.4 cm of water will wet the pedon to about 70 cm depth, assume no run-off or run-on and a soil that is at 15-bar tension at the beginning of the season.

			Ţ	Н	F	xchan	ge Pr	opert	ies					Tota	Chemi	cal An	alveis				
		(-)																			
Al <sup>+</sup> cn A2 <sup>+</sup> cn	o-15 15-32	0.21 0.14	8.1 7.0	7.3 6.8	2.1	1.0	0.1	0.3	<b>87</b> 77	4.0 3.5	0.9	77.0 72.7	8.0 7.6	5.4 6.0	0.90 0.97	1.49 1.49	1.84 3.12	0.71		<b>0.19</b> 0.18	1.8 1.3
B21t B22tg	32-52 52-76	0.10 0.15	7.2 5.5	5.3 4.8	1.6 4.7		0.4	0.1	a3 89	5.9 <b>19.1</b>	1.4 2.2	72.4 68.6		7.2 8.6	0.89	1.35	1.10 1.78	0.68 0.84			
B3ltsim B32tsim	76-101 101-152	0.06	5.6 5.7	<b>4.8</b> 5.3		5.7 4.0			87 86	12.2 12.5	1.5 1.4	65.4 68.6		10.5 7.6	1.44 1.53	0.97 1.04	3.56 2.52	1.74 1.45	2.8	<b>0.18</b> 0.11	
B33tsim B34tsim	<b>152-210</b> m-296	-	6.4 6.3	6.0 6.1	2.1	4.5	2.9	0.2	99 100+	9.3 10.9	1.4 1.3	68.8 71.0		7.8 5.9	1.63 1.60	1.11 1.11	3.52 2.40	1.73 1.26	1.8	0.10 <b>0.07</b>	
B35tsim B36tsi	<b>296-366</b> 366-466	-	6.3 6.5	6.1 6.1		11.5 <b>5.</b> 0		0.1 0.1	100+ 100+	8.4 8.0	1.3	67.3 71.3	11.2 10.5	7.7 6.0	1.73 1.65	1.09	4.04 2.68	1.07 1.39		0.15 <b>0.08</b>	
C5 CJ	466-520 520-580	- -	6.2 6.2	5.0 5.9	1.9 2.0		2.1	0.1 0.2	100 <sup>+</sup> 100 <sup>+</sup>	7.7 7.5	1.2 1.4		10.2 10.5	6.5 4.6	1.71 1.61	1.19 1.61	2.24 1.94	1.84 0.91			
Nodules Nodules												63.4 60.2		11.3 12.1	1.08 0.97	1.55 1.66	2.58 1.46	1.08' 0.98	3.b 3.1	0.39	4.2 Ա.և

TABLE 4 - Properties of the ISSS sand (2 - .02) of the Chesterton soil

						_		Chemi	cal Ans	lysis					
Harizon	Pepth, cm	Light	Heavy	Magnetite In Heavies	Li	ghts			Hea	vies (E:	xcludin	g Magn	etite)	}	
		Minerals	Minerals		A1203	Na <sub>2</sub> O	K20	SiO2	A1203	Fe203*	NaSo	K20	CaO	MgO	TiO2
	-	4-89-601-	d	of.						ď					
Alen Alen	0-15 15 <b>-3</b> 2	87.3 85.6 <b>87.6</b>	12.7 14.6	7.0 5.3 5.4	4.5 4.5	0.96 1.01	1.66 1.53	23.2 19.4	7.2 6.4	32.1 <b>3</b> 9.4	0.49 0.42		0.70 0.40		
921t 902tg	32-52 52-76	89.8	12.4 10.2	3.8	4.9 5.3	0.98 1.14	1.42 1.18	19.4 25.9	5.3 5.7	36.6 33.5			0.33 0.82		
SSltsim F32tsim	76-101 101-152	74.9 82.7	25.1 1'7.3	7.6 5.0	9 1 9 1	1.99 1.99	1.27 1.33	33.5 38.9	6.4 7.6	26.5 22.5	0.76 0.85	0.36	1.75 2.35	14.9 15.5	13.4 9.7
533tsim c3+tsim	152-210 210-296	78.0 87.2 <b>78.8</b>	22.0 12.8	6.2 2.7	8.7 7.6	2.13 1.96	1.26 1.35		7.9 8.7	22.2 20.8	0.91 0.96	0.41 0.44	2.40 3.33	16.8 18.1	
ejātsim Pļotsi	296-366 306-G	84.4	21.2 15.6	3.9 5.0	7.9 7 <b>.</b> 2	2.05 1.94	1.32 1.33	39.4 42.7	9.1 9.5	22.2 21.8	0.91 0.91	0.41 0.44	2.86 2.07	16.8 17.1	8.0 6.8
C-	466 <b>-</b> 520 520 <b>-</b> 550	81.8 31.3	18.2 8.7	4.6 7.2	7.9 0.3	1.99 1.79	1.27 1.66	39.4 40.0	7.9 7.9	22.9 22.2	0.91 0.01	0.41		17.6 17.0	

<sup>\*</sup> All Fe as  $Fe_2O_3$  + All analysis for soil without nodules

TABLE 5 - Pelative peak heights for the x-ray diffractograms of the Chesterton soil

Horizon	Depth, cm	Fine Clay	te/Clay Mica y Coarse Clay (0.002-0.0002)	Fine Clay	e/Cmentite Coarse Clay (0.002-0.0002
A) cn	0-15	1.8	1.3	2.9	1.6
A2 cn	15-32	2.0	1.3	3.7	1.4
B21t	32-52	2.4	1.0	2.4	2.9
B22tg	52-76	œ	1.7	0.9	2.2
B3ltsim	76-101	3.3	1.1	1.1	1.6
B32tsim	101-152	3.3 4.4	1.0	0.8	2.0
B33tsim	152-210	3.3	1.0	1.0	1.9 1.4
E37444	210-296	6.2	1.2	1.0	1.4
B36tsi	366-466	3-9	1.1	1.0	1.4
C1	<u>-56-520</u>	10.6	0.9	0.6	0.9
C2	520-580	1.8	0.É	2.0	1.6

TABLE  $\acute{o}$  - Selected micromorphological properties\* of the Chesterton soil :

Herizon	Depth, cm	Basic Structure	Plusmic Structure	Pedological Features
42 cm	15-32	Granular	Asepic	Spherical to subspherical, sesquioxidic, somewhat concentric sharp-bounded nodules.
B21t	32-52	Granular to intertextic	Argillasepic to skel-insepic	Less than 0.1% strongly separated, continuously oriented, void illuviation ferriargillans.
B22tg	52-76	Intertextic	Insepic	Abundant (from 25 to 50% of total plasma), moderately to strongly separated, striated and continuously oriented, free and embedded grain and void ferriargillans associated w/papules of similar characteristics.
B3ltsim	76-101	Granular		Very abundant (> 90% of total plasma) continuously oriented free and embedded grain ferriargillan-silans.
B32tsim	101-152	Granular	Mosepie (only in a few non-cutanic areas)	Very abundant (> 90% of total plasma) striated to continuously oriented free and embedded grain ferriargillan-silans associated in a few areas w/papules of similar characteristics.
B33tsim	152-210	Granular		Very abundant (> 95% of the total plasma) striated and continuously oriented free grain ferriargillan-silans.
B34tsim	210-296	Granular		As above (silans rare).
B35tsim	<i>2)</i> 6-366	Granular	Mosepic (only in small area)	As above (silans rare).
B36tsi	366-466	Granular		As above (silans rare).
Cl	466-520	Granular to intertextic	Mosepic (only in a few non-cutanic areas)	Abundant (between 50 to 75% of the total plasma) striated to continuously oriented free and embedded grain ferriargillans.

<sup>\*</sup> Terminology used is that of Brewer (1964).

# Chesterton Soil Concretions: Ilmenite and Not Iron-Manganese Cementing Matrix

Abstract. Dark reddish-brown spherules are common in soils of the Chesterton soil series of a high marine terrace in southern California. The spherules are concretionary in structure and are bound by ilmenite rather than by an iron-manganese complex. The spherules have been mislabeled both with respect to structure and mineralogy.

The Chesterton soil series is found primarily in San Diego County. California. The series occurs on the Linda Vista terrace, an old marine terrace, and is comprised of sandy materials derived from what appear to be ancestral beach ridges. Reddish-brown spherules ranging in size from pinheads to 3 cm occur within the surface horizons (Al I and A12) and in some cases on the surface. The A horizon is commonly 20 to 25 percent spherules (by weight). There has been much speculation about the true nature of these spherules, whether they are pebbles, nodules, or concretions (I). Pebbles are the product of physical rounding from some larger original specimen. Nodules are basically heterogeneous throughout. Concretions display concentric growth binding (2). There is also a question about the nature of the cementing agent. Are the quartz, sandsized grains held in a matrix of largely ferromagnesium minerals or in some other iron-rich mineral assemblage?

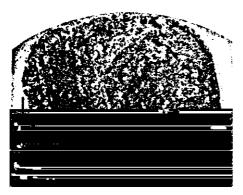


Fig.

1077

C

I

Superprobe

ilmenite quartz

2a).

2b),

35

2c).

Fig. 2. Results of an electron probe microanalysis of a spherule: (a) pattern obtained when the beam scans the quartz grain; (band c) two patterns that occur when the beam scans between the quartz grains.

the year, and a residual amount will remain when the groundwater is withdrawn during the dry season. An alternate hypothesis is that the clay is an inclusion present during spherule formation.

On the basis of these analyses and petrographic microscope investigations. the spherules can be considered quartz-ilmenite concretions. The concentric pattern of reddish-brown to dark reddish-brown

bands is visible to the naked eye. The band pattern is also present in SEM micrographs and in petrographic thin section. The binding agent for the concretion is ilmenite, not an iron-manganese complex. There is also a small amount of aluminosilicate clay, which may aid in the binding of the concretion. The spherules are true concretions cemented by an iron-titanium complex dominated by ilmenite.

This work suggests that caution be exercised in the terminology used for opaque spherules found in soils and sediments. Nodules and concretions are commonly termed ferromanganiferous; in this work the concretions are primarily iron in an ilmenite structure.

KENNETH L. WHITE

25

mill

Cu Ka monochromator.

diffracto-

tetrobromoethane 2.96),

seven

translocated

carried

groundwater

2c) I

Also located in this exposure are examples of "windows" as discussed by Nikiforoff, 1941, and others. Below is an excerpt from **Geoderma** by Torrent and Nettleton suggesting a hypothesis for their formation.

Duripans represent the incapacity of percolating water to leach silica that has been liberated in the weathering of ash or easily weatherable minerals. However, in many Durixeralfs, clay seems to have accumulated immediately above the duripan after it formed (Soil Survey Staff, 1975). This probably indicates a later period in the history of these soils when the supply of percolating water (able to translocate clay) was relatively high. Hydromorphic conditions above some duripans, e.g., mottling and concretions, give further support of this idea. All are evidence of a seasonal moisture excess such as that found several1 hundred kilometers north in today's Mediterranean climate (Torrent, Nettleton and Borst, unpublished data). In the time of the year in which this would occur, water would tend to percolate through the cracks or small channels (e.g., root channels) in the duripan thus dissolving the surrounding siliceous cement. Dissolution in the initial windows would continue, permitting more water to pass every year until: (a) a climatic change would preclude an abundant seasonal water supply; or (b) the overlying horizons would limit the speed of flow due to their intrinsic low conductivity; or (c) weathering and clay formation in and below the window would lower the hydraulic conductivity sufficiently to cause other windows to form; or (d) the number of windows per unit area in the landscape would limit the amount of water flowing laterally.

# Stop 5 Torrey Pines State Reserve

Torrey Pines State Reserve is a majestic wilderness island amidst an increasingly urban area. Its fragile environment is the home of the world's rarest pine **tree--Pinus** torreyana. Ten thousand years ago the tree may have covered a larger part of southern California, but now it grows naturally only here and on Santa Rosa Island, 175 miles to the northwest. Of an estimated six thousand or fewer native Torrey pines, an actual count in 1973 showed 3,401 young and mature trees growing within the thousand-acre Reserve.

SAN DIEGO NATURAL HISTORY MUSEUM
GEORGE BORST
Guide to Soils of Torrey Pines Mesa

The soils of western San Diego County are mostly slightly to medium acid in reaction and low in organic matter. They owe these properties to our rather unique climatic conditions, in which rainfall is confined to the cool winter months, so that there is enough moisture in most years to leach soluble minerals from the soil, but which provides moisture for only a limited amount of native vegetation. As a consequence, our soils are mostly rather light in color and weak in surface soil structure.

The soils on Torrey Pines Mesa conform to these characteristics. The simplest of these occur on the small dunes just to the north of the lodge and parking lot that have been classified as the Marina series. Typically, these have dark brown, medium acid loamy coarse sand surface soils, and somewhat lighter colored loamy coarse sand subsoils. In locations where they occur on more stable land surfaces, small thin wavy bands of reddish loamy sand or lamellae occur in the subsoil. These represent small increments of clay weathered from minerals in the surface soil, which have begun to move into the subsoil.

The Marina soils, as they occur in this area, probably resemble very much the earliest soils developed on Torrey Pines Mesa. This mesa was formed as an offshore ridge of dunes in early Pleistocene time, probably about one million years ago, when the land was very much lower in relation to the level of the sea. It has since been uplifted and subjected to intense erosion, both by encroachment of the sea cliffs on the west, by stream entrenchment on the east, and recently by removal of surface soil by both wind and water around the short canyons which have cut into the mesa from both east and west. The Marina soils probably represent an ideal soil for the survival of the relict Torrey pine trees, since their coarse sandy surface soils are capable of readily absorbing and storing small increments of moisture.

The predominant soils on the mesa to the south of the lodge are those of the Carlsbad series. These have dark brown medium acid loamy coarse sand surface soils, and pale brown slightly acid loamy sand subsoils, underlain by a brown weakly cemented sandy duripan. Small rounded iron concretions are common in the surface and subsoil. In extensive areas around the head of the canyon southwest of the lodge, much of the overlying soil has been stripped away by erosion, exposing this pan at the surface. This duripan undergoes irreversible hardening where it is exposed at or near the surface, and thus can be easily examined in such areas.

To the south of this canyon, there are **small** bodies of soils of the Chesterton series. Typically, these have dark brown medium acid fine sandy loam surface soils, and **mottled** brown and red medium acid sandy clay subsoils, underlain by a weakly cemented duripan. These soils usually occur in the concave portions of the landscape, in association with the Carlsbad soils. Some soil scientists believe that this association is the result of movement of soil water laterally transporting dissolved salts and suspended clay to these lower areas.

Somewhat farther south is a remnant of an old Indian camp site or kitchen midden soil. This is very much darker in color than the surrounding soil, and contains an abundance of marine shell fragments. Some of these middens have yielded bone, charcoal, and other materials of very great age, and an intense controversy has arisen as to the antiquity of man in San Diego County as a result of such finds in these soils.

# Stop 6 Clay Illuviation and Lamella Formations

Points to consider at this site are:

- 1. Genesis of the lamella
- 2.
- 3.
- 4.

TABLE 1. Selected morphological properties of the Psammentic Haploxeralf.

Horizon	Depth cm	Color	Texture	Structure	Consistency	Roots	Other	Boundary _
A11		7.5YR 3/3	18	massive to granular	very friable	many very fine		difíuse
A12	26-54	7.5YR 3/4	ls	weak coarse angular block	very friable y	many fine	one clam shell	diffuse
A13	54-87	7.5YR 3/4	18	weak coarse angular bloc	very friable ky	many fine	platy beach pebble	diffuse
A14	87-108	7.5YR 4/4 + 10YR 6/4 10YR 5/4 + 7.5YR 5/4(dry)	ls	weak coarse angular blocky	friable to firm slightly hard	common fine	clay bridges sands in some areas; horizon dry in some parts; few discontin- uous clay skins; few thin clay skins	
B21t		5YR 4/3	ls	massive	firm	few very fine	thickness variable (7-15 mm); clay bridgersand grains (lamella); clay skins thin in pores	abrupt was
<del>7.2</del>		10YR 4/4	1.5	massive	loose firm	few fine	sands are clea <sub>n</sub> (inter- lamella)	clear wavy
B22t	116-157	10YR 4/4(moist) 10YR 6/4(dry)	) ls	massive	firm hard	few very fine	clays bridge sand grains in discontinuous "random" lamellae; no clay skins	diffuse
B23t	157-216	10YR 5/4(moist) 7.5YR 5/6(dry)	) ls	massive	firm very hard slightly plastic	few very fine	clay bridges and coats sand grains; boundary of B23t situated at top of carbonate zone; channels of loose sand (10YR 6/4) permeate the horizon	diffuse
824t	216-286	5YR 5/6	a1	massive	very hard plastic slightly sticky	few very fine	some carbonate; there is a sand window 10 cm wide; lime coats the edge of it; clay bridges sand grains	gradual
B25t (lamellae)		10YR 5/4(moist) 7.5YR 5/6(dry)	1s	massive	very hard slightly plastic nonsticky		clay bridges sand grains; lamellae 2 cm thick; sand window continues	v-
B25t (interlame		10YR 5/4(moist) 10YR 6/4(dry)	) s	massive	loose			gradual
B26t (lamellae)		7.5YR 5/6	ls	massive	plastic slightly sticky		lamellae are ≥ 1.2 cm thick near top of the horizon and 0.5 cm near bottom	-2.
B26t (interlame		10YR 5/4	•	massive	loose	<b></b>		diffuse _
CI		10YR 6/4	8		sof t		sand with no lamellae	
C2	463-500		8		soft		sand with very few, thin (<0.5 cm) lamellae	
C3	500-555		8		soft	***	sand with many thin (3 mm) clay lamellae separate 25 mm	d
C4	555-564		9		loose		sand with no lamellae	

	Saluctud	nlivetent	propert	en est	the Po	ammentic Haplaxe	ralf		
7AKIL 7-	Selectivo	[//// A.J. D.1	ргарсте	( , () ,		American may rend	1071.		
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			•						
Al2	26-54 83	1.3 15.	.5 3.2	0.9	25.4	29.3 20.3 5.4	8.2	7.3	5.1
A13		1.5 15.			21.2	29.7 24.3 5.8	7.4	7.7	8.4
A14	87-108 82				22.1	30.4 24.2 5.8	7.5	8.2	10.4
821t	108-109 80				18.5	26.1 29.3 6.3	6.3	6.3	10.4
A2	109-116 89				20.7	33.1 30.1 4.8	5.2	2.8	10.6
622t	116-157 89				24.8	32.2 23.2 4.1	5.5	4.2	13.9
623t	157-216 84			0.8	27.1	33.1 21.1 2.6	3.7	3.1	23.3
824t	216-286 80	).4 6.	2 13.4	1.6	26.9	31.0 18.2 2.7	5.0	1.2	29.4
325t	286-356 89			1.4	26.4	35.3 23.4 2.7	4.0	2.1	36.2
326t	356-415 90	.7 8.	6 0.7	1.9	26.6	33.7 24.2 4.3	5.6	3.0	39.7
<u></u>	415-463 94	1.5 5.	3 0.2	4.7	38.6	34.7 14.8 1.7	4.1	1.2	42.2
<b>C2</b>	463-500 96	5.0 3.	9 0.1	7.1	38.4	35.6 13.7 1.2	3.5	0.4	43.7
<u>c2</u> c3	500-555 95	5.1 4.	7 0.2	1.6	34.2	36.9 21.0 1.4	4.0	0.7	47.1
C4	555-564 94	5 4.	5 1.0	1.6	29.3	32.0 29.9 1.7	4.1	0.4	47.6
Window	157-356 92	.5 5.	6 1.9	0.5	20.8	37.0 29.5 4.7	5.3:	0.3	
Lane									
B21t	80	12.		0.9	23.8	29.3 21.0 5.1	6.7	5.8	
B22t	78	.6 10.		0.5	24.9	28.9 20.0 4.3	6.1	4.8	·
<u>825t</u>		1.9 3.		2.1	28.7	31.8 18.6 2.7	ND	ND	
B26t (up	£ = *	.9 4.		3.4	29.6	30.8 20.8 3.3	3.1	0.9	
B26t (lo	•	9 4.		3.5	35.6	35.1 15.8 1.9	3.2	1.5	
Ç3	93	3.	2 3.4	2.0	39.9	32.8 16.7 2.0	2.2	1.0	

TABLE 3. Selected micromorphological properties of the Psammentic Haploxeralf.

Horizon	Depth	Basic Structuse	Plasmic Structure	Pedological Features
	сп			
Al l	0-26	granular	silasepic in places	
A14	87-108	granular	silasepic in places	# <del>-</del>
B21t	108-109	granular	almost all of plasma	thick (up to 200 pm) free and embedded grain, continuously
			occurs as pedological	oriented ferriargillans that constitute > 90% of total
			features	plasma
A2	109-116	granular	silasepic in places	
B22 t	116-157	granular	silasepic in places	alternating areas with ferriargillans similar to those
				of B21t and areas almost without any recognizable plasma
B23t	157-216	granular to	asepic in places	sometimes thick (up to 200 um) free and embedded grain.
		intertextic		continuously oriented ferriargillans that constitute
B24t	216-286	granular to	insepic in isolated	> 75% of total plasma: some CaCO3 tubules
DZUC	210-280	intertextic	patches	ferriargillans similar to those above constitute > 90%
2254	204 254			of total plasma
B25t	286-356	granular	all plasma occurs as	Lamellar areas show thick (up to 400µm) ferriargillans
			pedological features	bridging sand grains; interlamellar areas show only very
				thin (< 50 mm) argillans on very few sand grains
B26t	356-415	granular	all plasma occurs as	lamellar areas are similar to those above but thinner
			pedological features	(< 200µm); interlamellar areas also occasionally show
				thin argillans (< 50µm)
C)	415-463	granular	almost no plasma	there are no lamellae but some occasional thin argillans
				are concentrated in small areas

TABLE 4. Relative peak heights for the X-ray diffractogram of the Psammentic Haploxeralf.

Horizon	Depth cm	Kaolin Fine Clay (< 0.0002mm	ite/Clay Mica Coarse Clay (0.002-0.0002 <sub>77)</sub>
VII	0- 26	1. 6	1.1
A12	26- 56	1. 7	1.3
A13	54-87	1. 6	1.1
A14	87-108	1.6	1.3
B21t	108-109	2. 6	1.4
A2	109-116	1. 7	1.7
B22t	116-157	1.9	1.6
B23t	157-216	1.5	1.1
B24t	216-286	1.7	1.3
B25t	286-356	1.5	0.9
B26t	356-415	1.7	1.0
Cl	415-463	1.6	1.2
C2	463-500	1.4	1.5
C3	500-555	2.0	1.5
C4	555-564	1.5	1.0
Window	157-564	1.7	1.2
Lamellae		<b></b> .	
B21t		2.0	2.2
B22t		1.9	1.9
B25t		1.9	1.4
B26t (upper	r)	1.5	1.2
B26t (lower		1.5	1.2
C3	• •	1.3	1.1

$\omega$	
6	

	O-26	0.4,	9.4	6.9		0 1		1.3	100+	4 0	0.5	73 8	10 5	3.4	1.99	1 56	3 4	1.18	N 19	0 08	,
2	26-54	0.3,	7.9	6.7	2.2	0.4	1.5	1.2	2001	4.0	0.5	73.0	10.5	3.1	1.77	1.50	3.1		0.15	0.00	

(8)

TABLE 6. Properties of the International Society of Soil Science sands (ISSS) (2-.02 mm)of the Psammentic Haploxeralf.

Horizon	Depth	Light	Heavy	Magnetite				C	hemical	Analys	is *				
	•	Minerals	Minerals	in Heavies	1	ights			Heav	des (ex	cludir	g mag	netit	e)	
			%		A1201	Na <sub>2</sub> O	K20	\$102	A1201	Fc <sub>2</sub> O <sub>3</sub>	Na20	K20	CaO	MgO	TiO2
	cm							~~		X					
MΙ	0-26	88.6	11.4	3.5	8.3	2.13	1.56	39.4	9.8	19.7	0.96	0.42	2.89	16.0	6.8
A12	26-54	86.3	13.7	4.1	8.3	2.20	1.56	38.3	9.1	18.8	0.93	0.42	2.72	17.3	7.7
A13	54-87	86.3	13.7	4.4	9.1	2.20	1.58	38.3	8.3	20.1	0.98	0.44	2.56	17.4	7.8
A14	87-108	86.9	13.1	4.0	9.5	2.01	1.61	37.8	8.7	21.5	0.93	0.46	2.70	16.6	8.2
B21t	108-109	85.8	14.2	3.8	8.3	2.01	1.46	39.4	8.7	21.8	0.96	0.38	2.86	16.9	8.2
A2	109-116	85.7	14.3	4.0	8.7	2.25	1.54	38.9	8.7	23.2	0.93	0.40	2.68	16.8	8.3
B22t	116-157	87.0	13.0	4.6	7.6	2.20	1.50	37.3	8.3	21.1	0.96	0.38	2.84	17.1	8.5
823t	157-216	88.1	11.9	5.5	8.7	2.46	1.44	37.8	8.3	21.5	0.98	0.42	2.80	16.1	8.6
B24t	216-286	90.3	9.7	4.6	8.7	2.40	1.44	39.4	7.6	21.5	0.88	0.37	2.63	17.1	8.0
B25t	286-356	86.6	13.4	4.8	9.1	2.46	1.44	40.5	7.9	21.1	0.98	0.40	3.03	17.9	6.1
B26t	356-415	90.5	9.5	4.0	8.7	2.34	1.60	39.4	8.7	23.2	0.91	0.36	3.03	17.4	7.3
CI	415-463	92.2	7.8	4.1	6.3	2.11	1.68	35.6	8.3	24.4	0.96	0.34	2.52	15.9	9.4
C2	463-500	91.5	8.5	3.9	9.1	2.13	1.66	39.4	9.1	22.2	1.0%	0.31	2.93	16.1	7.8
C3	500-555	88.6	11.4	3.5	9.1	2.59	1.43	43.2	9.5	20.1	1.08	0.26	3.36	19.4	4.7
C4	555-564	95.0	5.0	2.6	10.2	2.94	1.70	43.2	7.9	17.9	0.93	0.46	3.36	20.9	3.8
Window	157-356	88.1	11.9	3.9	8.7	2.52	1.34	39.4	7.6	16.6	0.93	0.44	2.89	18.9	7.7
Lamel	lae														
B21t		86.4	13.6	4.2	9.1	2.20	1.58	37.8	8.7	21.5	0.93			16.1	
B22t		85.7	14.3	4.1	9.1	2.29	1.58	37.3	8.3	21.8	0.98			17.3	
B25t		87.2	12.8	3.7	9.8	2.52	1.44	40.0	8.7	21.1	1.01			18.3	6.3
B26t(upp	er)	86.9	13.1	5.4	9.1	2.40	1.56	38.9	8.3	21.5	0.93	0.35	2.61	17.9	6.3
B26t(low	er)	91.5	8.5	3.4	7.6	2.22	1.60	40.0	6.7	20.8	0.93	0.37	2.70	15.6	7.9
C3	•	92.0	6.0	2.5	9.1	2.43	1.51	42.1	8.7	14.9	1.13	0.37	3.43	20.9	3.5

(\*) All Fe as Fe<sub>2</sub>0<sub>3</sub>.

Table 7. Excess water (P-ETP) for November-March\*

Moisture Excess	Probability (+)	Years (one out of)	Depth of Wetting
> 154.3 > 172.3	0.10 0.05	10	162.7
> 207.4	0.01	20 100	169.6 183.0
7 240.4	0.001	1,000	233.4

Calculations based on data for the

- \* San Diego Airport Weather Station.
- (+) Assuming normal distribution.

TABLE 8. Climatic and calculated soil water storage data for the pedon and estimated climatic data and calculated soil water storage data for an earlier pedon.

				S	AN DIEGO	AIRPORT	WEATHER	STATION*					
STEP ITEM	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
Mean T. Deg. C	12.8	13.4	15.0	16.4	17.8	19.0	21.2	22.1	21.1	18.9	16.6	13.9	17.3
Monthly Pet Cm.	3.2	3.5	5.0	6.3	7.9	9.0	11.0	11.2	9.2	7.2	5.1	3.1	82.4
Monthly Prec. cm.	1.9	5.5	4."	2.0	0.4	0.1	0.0	0.2	0.4	1.2	2.3	5.2	26.4
PrecPet Cm.	3.2	2.0	-1.1	-4.2	-7.5	-8.8	-11.0	-11.0	-8.8	-6.0	-2.9	1.5	5.4
Month, Pet FFS		3.5	5."	6.3	7.9	9.0	11.0	11.2	9.2	7.2	5.1	3.8	82.5
	Avai	lable Wat	er Holding	Capacity	(AWC)	of the Ma	rina Pedo	n = 39.7	cm to 4	15 cm; 5.	4 cm to 5	7 cm	
Change in S Cm.	1.9	2.0	-1.1	-4.2	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
Storage (S) Cm.	3.4	5.4	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
Act. Et Cm.	3.2	3.5	5."	6.3	0.4	0.1	0.0	0.2	0.4	1.2	2.3	3.7	26.4
Act. ET FFS Cm.	3.2	3.5	5."	6.3	0.4	0.1	0.0	0.2	0.4	1.2	2.3	3.7	26.4
												ng = 0.0	
					SANTA	CRUZ WEA	ATHER STAT	'ION*				57 <b>c</b>	
Mean T. Deg. C	9.4	10.4	11.6	12.9	14.6	16.3	17.2	17.2	17.4	15.4	12.6	10.3	13.8
Monthly Pet Cm.	2.8	3.1	4.4	5.5	7.2	8.5	9.3	8.7	7.8	6.2	4.1	3.0	70.7
Monthly Prec. Cm.	17.4	14.8	10.5	5.4	2.6	0.5	0.1	0.2	0.7	3.5	7.0	16.8	79.4
Prec.~Pet Cm.	14.6	11.6	6.1	-0.2	-4.7	-7.9	-9.2	-8.6	-7.1	-2.7	2.9	13.8	49.0
Month. Pet FFS	0.0	0.5	4.4	5.5	7.2	8.5	9.3	8.7	7.8	6.2	4.0	0.0	62.2
	Ava	ilable Wa	ter Holdir	ig Capaci	ty (AWC)	of an Ea	arlier Mar	ina Pedor	1** = 33.	2 cm			
Change in S Cm.	14.6	0.8	0.0	-0.2	-4.7	-7.9	-9.2	-8.6	-2.6	0.0	2.9	13.8	0.0
Storage (S) Cm.	32.4	33.2	33.2	33.0	28.3	20.4	11.2	2.6	0.0	0.0	2.9	16.7	0.0
Act. Et Cm.	2.8	3.1	4.4	5.5	7.2	8.5	9.3	8.7	7.8	6.2	4.1	3.0	70.6
Act, Et FFS Cm.	0.0	0.5	4.4	5.5	7.2	8.5	9.3	8.7	7.8	6.2	4.0	0.0	62.1

<sup>\*</sup> U. S. Weather Bureau, 30 year normal monthly precipitation-temperature data - 1931-1960 - Card Deck 490.

<sup>\*\*</sup> Assume its water-holding capacity matched the A horizon of the modern Marina and that its other horizons match the C horizons of the modern Marina.

#### REFERENCES

Preliminary distribution of laboratory data - Redding Soils of the Kearney Mesa, San Diego County, California. Memorandum from R. E. Nelson to T. P. Helseth, April 13, 1967.

Pacific Cell Friends of the Pleistocene Field Trip Soils Tour Guide  $\blacksquare$  Borst, Nettleton, White, November 21, 1975

S.S.I.R. No. 24, California - USDA, Soil Conservation Service - June 1973

Personal Correspondence - Borst - February 9, 1972

Genesis of Some Typic Durixeralfs of Southern California - J. Torrent, Nettleton, Borst (unpublished)

Feedback Processes in Soil Genesis - Torrent, Nettleton - Geoderma, 20 (1978) 281-287

Chesterton Soil Concretions: Ilmenite and Not Iron-Manganese Cementing Matrix - Kenneth L. White - Sciences, Vol. 204, June 1979, pgs. 1077-1078

Clay Illuviation and Lamella Formation in a Psammentic Haploxeralf in Southern California - Torrent, Nettleton, Borst (unpublished)

The following are pages of interest taken directly from the San Diego County published soil survey.

Included are:

- (1) General description of the County
- (2) Climate
- (3) Farming
- (4) General Soil Map
- (5) Formation of Soils
- (6) Soil Classification Table
- (7) Land Resource Areas.

These sections should provide a fair overview of San Diego County and the various areas we will be passing through.

## SOIL SURVEY OF THE SAN DIEGO AREA, CALIFORNIA. PART I

(San Diego County excluding the Anza-Borrego and Cuyamaca State Parks)

#### BY ROY H. BOWMAN

SOILS SURVEYED BY ROY H.BOWMAN, ALAN A. HOUSE, GERALDKESTER, DAVID D.ESTRADA, JOHN K. WACHTELL,

SOIL CONSERVATION SERVICE; GERALD L. ANDERSON, FOREST SERVICE; AND PAUL V.CAMPO,

UNITED STATES MARINE CORPS

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE AND FOREST SERVICE, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION, THE UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, THE DEPARTMENT OF THE NAVY, UNITED STATES MARINE CORPS, THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, AND THE COUNTY OF SAN DIEGO PLANNING DEPARTMENT

SAN DIEGO COUNTY, the most southwesterly county in the continental United States, is bounded on the westby the Pacific Ocean. on the northby Orange and Riverside Counties, on the east by Imperial County, and on the south by Mexico. The county is roughly 70 miles from east towest and 60 miles from north to south. The elevation ranges from sea level to 6,535 feet.

The Area surveyed (fig. 1) is approximately 2,204,880 acres. It excludes the Anza-Borrego and the Cuyamaca State Parks but includes a small part of Riverside County north of Palomar Mountain. The physiography, the climate, and the vegetation vary widely.

The coastal plains rise sharply to nearly level terraces, dissected terraces, and rolling hills that support a natural cover of coastal chaparral and grassland. In the narrow winding valleys, oak is the dominant vegetation. In the center of the Area are the foothills, the narrow intermediate valleys, the mountains, and the plateaus of the Peninsular Range province. Chaparral, open woodland, and isolated areas of open grassland makeup the typical plant cover. The eastern part of the Salton Basin province is one of wide valleys separated by low irregular hills and mountains of multicolored beds of sandstone, shale, and conglowerate. The vegetation in this part is mainly a sparse cover of desert shrubs. cactus, and bunchgrass.

The climate ranges from mild marine along the coast to hot arid in the desert.

Since World War II, suburban expansion has transformed much of the farmland in the western third of the Area into urban-fringe areas. As a result, taxes and the cost of labor and real estate have increased out of proportion to farm income. Another factor that has added to the increased overhead is the high cost of importing water for irrigation from the Colorado River. Consequently, the only crops grown are those that have high gross returns

and do not compete with crops grown in other farming areas, or semitropical crops that are limited to a relatively frost-free climate, for example. avocados, citrus, flowers, tomatoes. truck crops, and other specialty crops.



Figure 1. -- Location of San Diego Area in California.

Poultry raising and dairying are important enterprises but occupy a very small acreage. No feed is raised on these farms. Dry lots, instead of pastures. are used in dairying. On poultry farms, the laying hens are caged throughout their

productive life.

Although 400,000 acres of the Area is used for range, ranching is not a" important enterprise. Much of the range is chaparral vegetation, which yields law-quality forage.

CLIMATE 1/

Climatic data for the whole of San Diego County are discussed in this section, although the Anza-Borrego and the Cuyanaca State Parks were "at covered by this soil survey (see figure 1).

ed by this soil survey (see figure 1).

The county has warm, dry summers and mild winters. It is made up of four physiographic provinces—the Coastal Plains, the Foothills, the Mountains, and the Desert. Temperature and precipitation data for each of these areas are given in table 1.

The Coastal Plains has the most equable climate of any area in the county; it has only light frost in winter. The Foothills have more variation in temperature and more precipitation than the Coastal Plains. The Mountain area has a wider range of temperature and receives more precipitation than either the Coastal Plains or the Foothills. The mean annual temperature is between 54' and 58°F. There is generally light snowfall in winter, but snow seldom stays on the ground for more than a few days. The Desert has the greatest variation in temperature and receives the least amount of precipitation of all the areas in the county.

Rainfall is heaviest during the period November to April and is infrequent in summer. The average total precipitation on the Coastal Plains is about 13 inches, and in the Mountains about 25 inches. The amount of rainfall diminishes rapidly down the

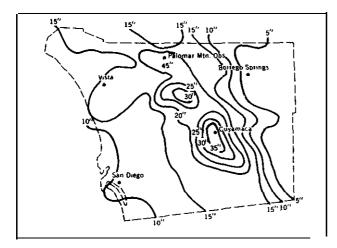


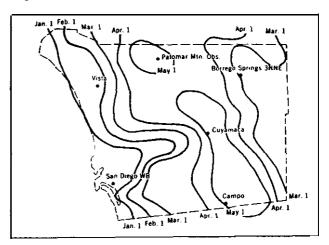
Figure 2.--Average seasonal precipitation.

east slope of the Mountains and averages 5 inches in the Desert (fig. 2). Humidity is fairly high on the Coastal Plains in summer because of fog along the coast and is fairly low in the Desert on summer afternoons. The rest of the year it is moderate throughout the county.

Moderate temperatures prevail on the Coastal Plains. The growing season, or the period between the last freezing temperature in spring (fig. 3) and the first in fall (fig. 4), is 280 to 360 days. Sloping areas, which have the best air drainage and the least amount of frost, are desirable for avocados, citrus, and other frost-sensitive crops.

dos, citrus, and other frost-sensitive crops.

I" the Foothills the growing season is 220 to 340 days. The mea" annual temperature is between 59' and 63'. The average date of the first freeze in fall is December 1, and the last in spring February 1. Sloping areas, which have better air drainage and less frost than level areas, are desirable for avocados. citrus. and other frost-sensitive crops



<u>Figure J.</u>--Average date of last 32" temperature in spring.

By C. ROBERT ELFORD, State climatologist, and JOHN STILZ, assistant climatologist, National Weather Service, San Francisco. Calif.

In the Mountains the growing season is 150 to 200 days, which is the shortest in the county. The average dates of the first and the last freeze are November 1 and May 1, respectively. The mean maximum temperature in July is between 85° and 95°, and the mea" minimum in January between 28° and 34".

The growing season in the Desert is 210 to 260 days. The first freeze occurs about December 1, and the last about March 1. The mean maximum temperature in July is between 100° and 105°, and the mean

minimum in January is 36".

Winds are generally light; in fact, less than 8 miles per hour 64 percent of the time. Except for persistent westerly winds along the coast during summer afternoons, they vary in direction. Strong winds are associated with the east side of the Mountains, which slopes down to the Desert. The strongest winds are usually associated with occasional migrant storms that cross the county in winter.

Three or four times a year, usually in fall or in winter, pressure conditions cause a fairly strong, gusty flow of air from the north or east. This air is usually dry and at times is unseasonably warm.

Jan 1 Nov 1 Dec. 1

Pajdmar Min Obs.
Borrego Springs 3NNE

Oct. 1

Campo

Nov. 1

Dec. 1

Nov. 1

Dec. 1

Figure 4.--Average date of first 32° temperature in fall.

**FARMING** 

The Spanish introduced farming into San Diego County in 1769 with the establishment of Mission San Diego de

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA FOR FOUR WEATHER STATIONS IN SAN DIEGO AREA, CALIF.

[County of San Diego, Natural Resources Annual Report for years 1958-67. Data from National Weather Service]

Coastal	plain:	San	Diego,	Calif.
rı	Elevatio	n 19	feet.	

January 6 February 6 March 7 May 7 July 7 August 6 November 6 Year 7  January 6 March 7  January 6 March 7  July 8 July 8 July 8 July 8 July 8 September 8 November 7	Mean high  "F.  66.3  66.3  66.3  71.9  69.1  70.7  75.6  78.0  77.4  75.9  69.9  66.5  71.2	Mean 10w °F. 47.1 48.9 51.0 55.6 57.4 60.0 63.9 66.2 64.0 59.5 53.0 48.1 56.2		#ighest  *F.  83  85  88  86  91  85  93  89  111  107  97  88  111  Escondido, C	*F. 31 38 42 47 48 51 57 61 56 48 38 35 31	Days 32° F. or below  No.  0.1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Total  In.  1.29 1.45 1.14 1.65 0.15 0.06 0.03 0.02 0.30 0.14 1.53 1.61 9.34
February	66.3 66.3 71.9 69.1 70.7 75.6 78.0 77.4 75.9 69.9 66.5 71.2	47.1 48.9 51.0 55.6 57.4 60.0 63.9 66.2 64.0 59.5 53.0 48.1	56.7 57.6 58.7 63.8 63.3 65.4 69.8 72.1 70.7 67.7 61.5 57.3 63.2	83 85 88 86 91 85 93 89 111 107 97 88	31 38 42 47 48 51 57 61 56 48 38 35 31	0.1 0 0 0 0 0 0 0 0 0	1.29 1.45 1.14 1.65 0.15 0.06 0.03 0.02 0.30 0.14 1.53 1.61
February	66.3 66.3 71.9 69.1 70.7 75.6 78.0 77.4 75.9 69.9 66.5 71.2	48.9 51.0 55.6 57.4 60.0 63.9 66.2 64.0 59.5 53.0 48.1	57.6 58.7 63.8 63.3 65.4 69.8 72.1 70.7 67.7 61.5 57.3 63.2	85 88 86 91 85 93 89 111 107 97 88	38 42 47 48 51 57 61 56 48 38 35	0 0 0 0 0 0 0 0	1.45 1.14 1.65 0.15 0.06 0.03 0.02 0.30 0.14 1.53 1.61
March	66.3 71.9 69.1 70.7 75.6 78.0 77.4 75.9 69.9 66.5 71.2	51.0 55.6 57.4 60.0 63.9 66.2 64.0 59.5 53.0 48.1	57.6 58.7 63.8 63.3 65.4 69.8 72.1 70.7 67.7 61.5 57.3 63.2	88 86 91 85 93 89 111 107 97 88 111	42 47 48 51 57 61 56 48 38 35	0 0 0 0 0 0 0 0	1.14 1.65 0.15 0.06 0.03 0.02 0.30 0.14 1.53 1.61
April	71.9 69.1 70.7 75.6 78.0 77.4 75.9 69.9 66.5 71.2	55.6 57.4 60.0 63.9 66.2 64.0 59.5 53.0 48.1	63.8 63.3 65.4 69.8 72.1 70.7 67.7 61.5 57.3 63.2	86 91 85 93 89 111 107 97 88	47 48 51 57 61 56 48 38 35	0 0 0 0 0 0 0	1.65 0.15 0.06 0.03 0.02 0.30 0.14 1.53 1.61
May	69.1 70.7 75.6 78.0 77.4 75.9 69.9 66.5 71.2	57.4 60.0 63.9 66.2 64.0 59.5 53.0 48.1	63.3 65.4 69.8 72.1 70.7 67.7 61.5 57.3 63.2	91 85 93 89 111 107 97 88 111	48 51 57 61 56 48 38 35	0 0 0 0 0 0	0.15 0.06 0.03 0.02 0.30 0.14 1.53 1.61
June	70.7 75.6 78.0 77.4 75.9 69.9 66.5 71.2	60.0 63.9 66.2 64.0 59.5 53.0 48.1	65.4 69.8 72.1 70.7 67.7 61.5 57.3 63.2	85 93 89 111 107 97 88 111	51 57 61 56 48 38 35 31	0 0 0 0 0 0	0.06 0.03 0.02 0.30 0.14 1.53 1.61
July	75.6 78.0 77.4 75.9 69.9 66.5 71.2	63.9 66.2 64.0 59.5 53.0 48.1	69.8 72.1 70.7 67.7 61.5 57.3 63.2	93 89 111 107 97 88 111	57 61 56 48 38 35 31	0 0 0 0 0	0.03 0.02 0.30 0.14 1.53 1.61
August	78.0 77.4 75.9 69.9 66.5 71.2	66.2 64.0 59.5 53.0 48.1	72.1 70.7 67.7 61.5 57.3 63.2 Foothills:	89 111 107 97 88 111	61 56 48 38 35 31	0 0 0 0	0.02 0.30 0.14 1.53 1.61
September	77.4 75.9 69.9 66.5 71.2	64.0 59.5 53.0 48.1	70.7 67.7 61.5 57.3 63.2	111 107 97 88 111	56 48 38 35 31	0 0 0 0	0.30 0.14 1.53 1.61
October	75.9 69.9 66.5 71.2	59.5 53.0 48.1	67.7 61.5 57.3 63.2 Foothills:	107 97 88 111	48 38 35 31	0 0 0	0.14 1.53 1.61
November   60	69.9 66.5 71.2	53.0 48.1	61.5 57.3 63.2 Foothills:	97 88 111	38 35 31	0	1.53 1.61
December Year 7         January 6         February 6         March 7         June 8         July 8         August 8         September 8         November 7	66.5	48.1	57.3 63.2 Foothills:	88 111	35 31	0	1.61
Year     7       January     6       February     6       April     7       May     8       July     8       July     8       September     8       November	71.2		63.2 Foothills:	111	31	•	
January 6 February 6 March 7 May 8 July 8 September 8 November 7	<u></u>	56.2	Foothills:			0.1	9.34
February       6         March       6         April       7         May       7         June       8         July       8         August       8         September       8         October       8         November       7	66.9			Escondido, C			<u> </u>
February       6         March       6         April       7         May       7         June       8         July       8         August       8         September       8         October       8         November       7	66.9		illevat	ion 700 feet			
February       6         March       6         April       7         May       7         June       8         July       8         August       8         September       8         October       8         November       7	66.9		<del></del>				1
March       6         April       7         May       7         June       8         July       8         August       8         September       8         October       8         November       7		37.8	52.4	86	23	7.6	1.67
April 7 May 8 June 8 July 8 September 8 November 7	67.2	40.4	53.8	92	28	2.5	2.30
May	68.3	42.7	55.5	89	29	1.0	2.07
June	73.1	46.6	59.9	97	35	0	1.71
July       8         August       8         September       8         October       7         November       7	75.6	51.1	63.3	97	39	0	0.24
August 8 September 8 October 7	80.1	55.0	67.6	96	41	0	0.07
September 8 October 8 November 7	87.8	58.5	73.1	105	47	0	0.07
October 8 November 7	88.5	61.1	74.9	103	50	0 0	0.03
November 7	84.8	57.6	71.2	105 101	45 38	0	0.39
	80.2	52.0 44.2	66.1 57.8	93	25	0.9	2.26
December C	71.3	39.6	53.5	89	26	3.5	2.35
	67.3 75.1	48.9	62.4	105	23	15.5	13.49
<u>,</u>	<u>_</u> _	1			atory, Calif.	<u></u>	<u>I</u>
·-·			[Eleva	tion 5,515 f	eet j	<del></del>	T
]						1/,,,	2.05
	54.6	33.9	44.3	78	13	11.8	2.95
	54.9	34.1	44.5	76	15	12.1	3.92
	56.6	34.4	45.5	82	16	14.1	3.61
	62.5	39.1	50.8	83	22	9.5	3.77
,	68.5	43.9	55.2	88	24	3.2	0.35
	77.0	54.4	64.7	93	28	0.9	0.11
	84.2	60.8	72.6	95	49	0	0.27
	84.8	60.8	72.8	94	38	0	0.37
	79.9	54.4	67.2	93	35	0	0.73 0.40
	74.3	49.2	61.8	90	24	0.9	
November 6		39.5	50.7	80	17	5.8	4.49
December S	61.8	35.6	46.0	80	10	8.6	5.37
Year 6			56.3	95	10	66.9	26.34

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA FOR FOUR WEATHER STATIONS IN SAN DIEGO AREA, CALIF.--Continued

Desert: Borrego Springs, Calif. [Elevation 500 feet]

			Тетр	erature			Precipitation
Month	Mean high	Mean low	Monthly mean	Highest	Lowest	Days 32° F. or below	
	°F.	<u>°F.</u>	<u>°F.</u>	°F.	°F.	<u>No.</u>	In.
January	69.5	36.7	53.1	89	20	7.9	0.25
February	73.4	41.8	57.6	91	25	2.3	0.43
March	76.9	45.9	61.4	93	26	0.6	0.26
April	83.8	51.4	67.6	102	37	0	0.14
May	90.4	56.9	73.7	111	40	0	0.02
June	98.9	63.7	81.3	115	48	0	0.00
July	105.1	70.8	88.0	117	55	0	0.13
August	103.5	71.5	87.5	114	56	0	0.26
	<u>1</u> /	<u>1</u> /	1/	1/	1/		
September	88.6	56.5	72.6	111	42	0	0.21
	1/	<u>1</u> /	1/	1/	1/		
October	1/ 81.5	49.9	65.7	105	37	0	0.35
November	77.0	45.9	61.4	97	23	0.9	0.61
December	69.8	38.7	54,3	89	21	3.8	0.61
Year	84.9	52,5	68.7	117	20	15.5	3.27

 $<sup>\</sup>frac{1}{B}$  Based on 9 years reporting.

The general soil map (see box containing detailed soil maps) shows, in color, the soil associations in the San Diego Area. A soil association is a land-

1. Mecca-Indio Association

Well-drained sandy loams and silt loams on alluvial

soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an Area, who want to compare different parts of an Area, or

This association is made up of soils that developed in alluvium derived from acid igneous rock and mica schist. It occurs in the Desert. The elevation ranges from 100 to 2,500 feet. The mean annual precipitation is between 3 and 8 inches, and the

Rositas soils are used for vineyards, citrus, pasture, and alfalfa. Nonirrigated areas are used for range. Some areas are subject to occasional overflow.

#### 3. Rositas-Carrizo Association

Somewhat excessively drained and excessively drained loamy coarse sands to very gravelly sands on alluvial fans; 2 to 9 percent slopes

This association is made up of soils that developed in alluvium derived from acid igneous rock and mica schist. It occurs in the Desert. The elevation ranges from 100 to 2,000 feet. The mean annual precipitation is between 4 to 7 inches, and the mea annual air temperature between 68" and 74' F. The frost-free season is 210 to 270 days. The vegetation consists mostly of desert shrubs, cactus, and annual grasses.

This association occupies about 2 percent of the San Diego Area. Rositas soils make up about 60 percent of the association, and Carrizo soils about 25 percent. Mecca soils and small area\* of sand dunes make up the remaining 15 percent.

Rositassoils are somewhat excessively drained, light brownish-gray loamy coarse sands and fine \*and\* that have a substratum of pale-brow" fine gravelly loamy coarse sand. Carrizo soils are excessively drained, very pale brown very gravelly sands and fine sands. They have a substratum of very pale brown very gravelly coarse sand.

Irrigated areas of Rositas soils are used for citrus. alfalfa, and pasture. Nonirrigated areas are used for range. Carrizo soils are

Group II. Excessively Drained to Well-Drained, Gently Sloping to Strongly Sloping Loamy Coarse Sands to Sandy Loams on Alluvial Fans and in ins in Mountainous Areas

#### 4. Mottsville-Bull Trail Association

sands and sandy loams on alluvial fans and in basins; 2 to 15 percent slopes

Group III. Excessively Drained to Moderately Well Drained, Nearly Levelto Moderately Sloping Loamy Sands to Clays on Alluvial Fans and Alluvial Plains in Foothill and Coastal Plain Areas

The soils in this group are excessively drained to moderately well drained sands, loamy sands, sandy loams, gravelly sandy loams. clay loams, and clays. They formed in material derived from marine sandstone and shale and granitic rock. Slopes range from 0 to 9 percent.

The elevation ranges from near sea levelto 2,000 feet. The average annual rainfall is between 10 to 18 inches, and the average annual air temperature between 60° and 62" F. The frost-free season is 240 to 340 days. The vegetation consists of annual grasses and forbs, shrubs. and scattered oaks.

These soils are used for flowers, citrus, truck crops, nursery stock, and range. Urbanization is expanding in many areas.

Two associations of the San Diego Area are in this group. They represent about 4 percent of the Area.

#### 6. Salinas-Corralitos Association

Moderately well drained to somewhat excessively drained clays, clay loams, and loamy sands on alluvia, fans; 0 to 9 percent slopes

This association is made up of soils that dewoped in alluvium derived from marine sandstone and sediments washed from adjacent soils. It is on the Coastal Plains. The elevation ranges from 25 to 300 feet. The mean annual precipitation is between 10 and 14 inches, and the mean annual air temperature between 60" and 62° F. The frost-free season is 300 to 540 days. There is only light frost in winter. The vegetation consists mostly of red brome, ripgut brome, flattop buckwheat, sumac, annual grasses and forbs, and scattered trees.

This association occupies about 1 percent of the San Diego Area. Salinas soils make up about 60 percent of the association, and Corralitos soils about 30 percent. Chino and Tujunga soils make up the remaining 10 percent.

Salinas soils are well drained and moderately we, drained, dark grayish-brown clay loams or clays. They have a substratum of very dark grayish-brown clay loam and clay. Corralitos soils are somewhat excessively drained, grayish-brown loamy sands. They have a substratum of brown loamy sand.

These soils are used mostly for flowers and truck crops; a large variety of flowers and vegetables is grown under intensive management. Urbanization is advancing into this association along the coastal area.

## 7. Visalia-Tujunga Association

Moderately well drained and excessively drained sandy loams to sands on alluvial fans and alluvial plains; 0 to 9 percent slopes

This association is made up of soils that developed in alluvium derived predominantly from granitic rock. It is onthe Coastal Plains and in the Foothills. The elevation ranges from sea levelto 2,000 feet. The mean annual precipitation is between 10 and 18 inches, and the mean annual air temperature between 60' and 62" F. The frost-free season is 240 to 320 days. The vegetation consists mostly of annual grasses and forbs and a few scattered pats

This association occupies about 3 percent of the San Diego Area. Visalia soils make up about 60 percent of the association, and Tujunga soils about 25 percent. Ramona, Placentia, Fallbrook, and Vista soils and Clayey alluvialland make up the remaining 15 percent.

Visalia soils are moderately well drained, dark grayish-brown sandy loams or gravelly sandy loams. They have a substratum of dark grayish-brown sandy loam or gravelly sandy loam. Tujunga soils are excessively drained, brawn sands. They have a substratum of pale-brawn sand.

These soils are used mostly for truck crops, flowers, citrus, nursery stock, and range. Flowers and nursery stock are grown near the coast. Citrus and truck crops are grown inland as well as in the coastal area. Urban, industrial, and recreational uses are increasing, even though flooding is a hazard in some parts of this association.

Group IV. Somewhat Excessively Drained to Moderately We, Drained, Nearly Levelto Steep Loamy Coarse Sands to Clay Loams on Terraces in Foothill and Coastal Plain Areas

The soils in this group are somewhat excessively drained to moderately we,, drained loamy coarse sands to gravelly clay loams that have a loamy coarse sand to clay subsoil. In some areas these soils are underlain by a hardpan. They formed in alluvium derived from a variety of rocks. Slopes are generally between 2 and 15 percent but range from 0 to SO percent.

The elevation ranges from near sea levelto 1,800 feet. The average annual rainfall is between 10 and 18 inches, and the average annual air temperature between 60' and 62' F. The frost-free season is 260 to 350 days. The vegetation consists of annual grasses and forbs, shrubs, and a few scattered paks

The soils on the Coastal Plains are used for irrigated citrus, truck crops, flowers. and avocados, and those in the Foothills for irrigated citrus and pasture. ""developed areas are used for range. Urban use is increasing.

Five associations of the San Diego Area are in this group. They make up about 11 percent of the Area.

v	Ramona	レミっとロ	ntı 1	Asso	- 1 · t	1 011
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Well drained and moderately well drained sandy loams that have a subsoil of sandy clay loam to sandy clay over granitic alluvium; 2 to 15 percent slopes

This association is made up of soils that developed in alluvium derived from granitic rocks. It is in the Foothills. The elevation ranges from 200 to 1,800 feet. The mean annual precipitation is between 14 and 18 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 260 to 320 days. The

9.	Marina-Chesterton	Association

These soils are of little value for farming and ranching. Open areas are mainly idle. Industrial and urban developments occupy large areas and are continuing to expand in the area of Clairemont and Miramar.

# 12. Redding-Olivenhain Association

Well-drained gravelly loams and cobbly loams that have a subsoil of gravelly clay and very cobbly clay over a hardpan or cobbly alluvium; 9 to 50 percent slopes

This association is made up of soils that developed on old gravelly and cobbly marine terraces deeply dissected by numerous drainageways. It occurs on the Coastal Plains. It is characterized by tortuous divides and deep V-shaped valleys that have steep side slopes. The elevation ranges from 100 to 600 feet. The mean annual precipitation is between 10 and 16 inches, and the mea"

open stands of mixed coniferous and deciduous trees and an understory of shrubs and grasses.

This association occupies 2 percent of the San Diego Area. Crouch soils make up about 90 percent of the association. Holland soils, La Posta soils, and Loamy alluvial land make up the remaining 10 percent.

Crouch soils have a surface layer of dark grayish-brown coarse sandy loam and a subsoil of yellowish-brown sandy loam. They overlie weathered granodiorite that is several feet thick. Rock outcrops, stones, and boulders cover about 2 to 10 percent of the surface.

These soils are used mainly for range, wildlife habitat, and watershed. The woodland on this association is of little or no importance in the production of timber. Wooded areas are used as recreational areas and as sites for summer cottages.

#### 15. Crouch Association, Rocky

# Well-drained coarse sandy loams over weathered granodiorite; 30 to 75 percent slopes

This association is made up of soils that developed in material derived from granodiorite. It occurs in the Mountains. The elevation ranges from 3,000 to 8,000 feet. The mean annual precipitation is between 20 and 35 inches, and the mean annual air temperature between 53° and 55° F. The frostfree season is 135 to 175 days. The vegetation consists of open stands of mixed coniferous and deciduous trees and an understory of shrubs and grasses.

This association occupies 2 percent of the San Diego Area. Crouch soils make up about 85 percent of the association. La Posta soils, Sheephead soils, and areas of rock land make up the remaining 15 percent.

Crouch soils have a surfacelayer of dark gray-ish-brown coarse sandy loam and a subsoil of yellow-ish-brown sandy loam. They overlie weathered grano-diorite that is several feet thick. Rock outcrops and boulders cover about 2 to 10 percent of the surface.

These soils are used mostly for range, wildlife habitat, watershed, and recreational areas. The woodland on this association is of little or no importance in the production of timber.

16.LaPosta-KitchenCreek Association, Rocky, Eroded

Somewhat **excessively** drained loamy coarsesands over decomposed granodicrite; 5 to 15 percent slopes

This association is made up of soils that devel oped in material derived from granitic rock. It occurs on uplands in the Mountains. The elevation

ranges from 2,000 to 4,500 feet. The mean annual precipitation is between 12 and 20 inches, and the mean annual air temperature between 56° and 58° F. The frost-free season is 160 to 190 days. The vegetation consists of chaparral, mainly chamise, red shank, scrub oak, and flattop buckwheat.

This association occupies about 2 percent of the San Diego Area, La Posta soils make up about 70 percent of the association, and Kitchen Creek about 20 percent. Mottsville and 'Tollhouse soils make up the remaining 10 percent.

La Posta soils have a surface layer of grayish-brown loamy coarse sand and ii substratum of brown loamy coarse sand. Below this is decomposed granodiorite. Rock outcrops and boulders cover 2 to 10 percent of the surface. Kitchen Creek soils have a surface layer of dark-brown loamy coarse sand and a subsoil of pale-brown coarse sandy loam. Below this is decomposed granodiorite.

These soils are used mainly for range, wildlife habitat, and watershed. Large areas would be suitable for farming or for housing developments if water could be made available.

# 17. Tollhouse-La Posta-Rock Land Association, Eroded

Excessively drained and somewhat excessively drained coarse sandy loams and loamy coarse sands overgranitic rock, and areas of rockland;9 to

#### 18. Sheephead Association, Rocky

# well-drained cobbly fine sandyloams over fractured mica schist; 9 to 65 percent slopes

This association is made up of soils that developed in material derived from mica schist. It occur-5 in the Mountains. The elevation ranges from 3,000 to 6,000 feet. The mean annual precipitation is between 20 and 30 inches, and the mea" annual air temperature between 56° and 58° F. The frost-free season is 160 to 185 days. The vegetation is chaparral. including chamise and manzanita, and a few annual grasses.

This association occupies about 1 percent of the San Diego Area. Sheephead soils make up about 70 percent of the association. Tollhouse and Holland soils make up the remaining 30 percent.

Sheephead soils have a surface layer of dark grayish-brown cobbly fine sandy loam. Below this is fractured mica schist. Rock outcrop covers 2 to 10 percent of the surface.

These soils are used mainly for range, watershed, and wildlife habitat.

#### 19. Sheephead, Rocky-Bancas Association

Well-drained cobbly fine sandy loams and stony loams over mica schist and quartz diorite: 30 to 65 percent slopes

This association is made up of soils that developed in material weathered in place from mica schist and quartz diorite. It occurs in the Mountains. The elevation ranges mainly from 2,000 to 6,000 feet. Itisless than 1,000 feet on a small acreage of Bancas soils. The mea" annual precipitation is between 18 and 30 inches, and the mea" annual air temperature between 56° and 58°F. The frost.-free season is about 160 to 230 days. The vegetation consists of chamise, manzanita, scrub oak. ceanothus, California sagebrush, and annual forbs and grasses.

This association occupies about 7 percent of the San Diego Area. Sheephead soils make up about 55 percent of the association, and Bancas about 30 percent. Tollhouse soils, Las Posas soils, La Posta soils, and small areas of rock land make up the remaining 15 percent.

Sheephead soils have a surface layer of dark grayish-brown cobbly fine sandy loam. Below this is fractured mica schist. Rock outcrop covers 2 to 10 percent of the surface. Bancas soils have a surface layer of brown stony loam and a subsoil of yellowish-red clay loam. This is underlain by decomposed granitic rock.

These soils are used for range, watershed, and wildlife habitat.

# Group VI. Excessively Drained to Moderately Well Drained, Gently Sloping to Very Steep Sandy Loams to Silt Loams on Uplands in Foothill Areas

The soils in this group are excessively drained to moderately we,, drained sandy loams to silt loams that have a coarse sandy loam to clay subsoil. They are derived from granitic rack, gabbro, tonalite, metavolcanic rock, and metasedimentary rock. Rock outcrops or stones cover up to 10 percent of the surface in many areas. Slopes range from 2 to 75 percent.

The elevation ranges from 200 to 3,500 feet. The average annual rainfall is between 12 and 20 inches, and the average annual air temperature between 59" and 64°F. The frost-free season is 240 to 340 days. The vegetation consists chiefly of a chaparral-type cover and a" understory of annual grasses and shrubs. A" oak-savannah type cover grows on the more gentle slopes. Scattered oaks and other tree species grow along

21. Fallbrook-Vista Association, Rocky

Well-drained sandy loams and coarse sandy loams that have a subsoil of sandy clay loam and sandy loam over decomposed granodiorite; 9 to 30 percent slopes

This association is made up of soils that developed in material weathered from granitic rock. It occurs on uplands in the Foothills. The elevation ranges from 200 to 2,500 feet. The mean annual precipitation is between 14 and 18 inches, and the mean annual air temperature between 60° and 64° F. The frost-free season is 260 to 320 days. The vegetation consists of white and black sage, sumac, flattop buckwheat, soft chess, wild oats, forbs, and a few California live oaks.

This association occupies about 6 percent of the San Diego Area. Fallbrook soils make up about 45 percent of the association, and Vista soils about 40 percent. Cieneba, Visalia, and Bonsall soils make up the remaining 15 percent.

Fallbrook soils have a surface

23. Cieneba-Fallbrook Association. Very Rocky

Excessively drained to well-drained coarse sandy loams and sandy loams that have a sandy clay loam subsoil over decomposed granodiorite; 9 to 75 percent slopes

6	1	0	p	e	S	

loam, a subsoil of reddish-brown stony clay loam, and below this, weathered metavolcanic rock.

These soils are used chiefly for range, watershed and wild life habitat.

25. Exchequer-San Miguel Association, Rocky

# $\frac{Well\text{-}drained\ siltloams\,over\,metavolcanic\,rock;30}{to\ 75\ percent\ slopes}$

This association is made up of soils that developed in hard metavolcanic rock. It occurs in the Foothills. The elevation ranges from 400 to 3,300 feet. The mean annual precipitation is between 13 and

## 28. Diablo-Linne Association

Well-drained clays and clay loams; 15 to 50 percent slopes

This association is made up of soils that developed in material derived from soft

Moderately well drained loamy fine sands to loams that have a subsoil of sandy clay or clay; 9 to 30 percent slopes

Diablo soils are dark-gray clays. Linne soils are gray clay loams. These soils overlie light-gray to white, calcareous shale and sandstone. In many places the surface layer is moderately to strongly cal-

29. Diablo-Las Flores Association

31. Gaviota-Hambright Association, Eroded

Well-drained fine sandy loams and gravelly clay loams over sandstone and breccia; 30 to 75 percent slopes

Diablo soils are well-drained, dark-gray clays. Las Flores soils are moderately well drained and have a surface layer of light brownish-gray loamy fine sand and a subsoil of grayish-brown sandy clay.

# Group VIII. Miscellaneous Land Types of the Desert, Mountains, Foothills, and Coastal Plains

The miscellaneous land types in this group vary considerably in soil characteristics and qualities. They are used only for wildlife habitat, watershed, and recreational areas.

Three **associations** in the San Diego Area are in this group. They represent about 12 percent of the Area.

# 32. Rough Broken Land-Terrace Escarpments-Sloping Gullied Land Association

# Steep and very steep dissected land, escarpments, and gullied land

This association is made up of areas that are of no value for farming and ranching. It occurs in the Desert, in the Mountains, in the Foothills, and on the Coastal Plains. Some of these areas are almost barren; some have a moderate cover of chaparral.

This association occupies about 2 percent of the San Diego Area. Rough broken land makes up about 45 percent of the association, Terrace escarpments about 25 percent, and Sloping gullied land about 15 percent. Tollhouse, Sheephead, Cieneba, and Hambright soils make up the remaining 15 percent.

Rough broken land is deeply dissected by narrow V-shaped "alleys and sharp tortuous divides. Many areas are barren and are rapidly eroding. The vegetated areas have a thin mantle of soil. This land type formed mainly over gravelly to loamy sediments. A few areas overlie weak sandstone and shale.

Terrace escarpments occur as steep to very steep, relatively even fronts of terraces and coastal plains. They also occur as irregular areas between narrow alluvial terraces and the adjoining smooth uplands. The underlying material consists of recent sediments or soft marine sandstone and shale.

Sloping gullied land consists of relatively barren areas that are dissected by numerous actively eroding gullies or by single deeply entrenched gullies that have very steep sides. In many places the gullies are eroding into the soft sandstone, shale, and decomposed granite.

These miscellaneous land types are used mainly for watershed.

#### 33. Badland Association

#### Dominantly barren eroded shales

This association is made up of moderately sloping to steep, essentially barren areas that are dissected by few to numerous intermittent drainageways. It occurs in the Desert. It is underlain by shale, soft sandstone. and silty, sandy, and gravelly sediments. Runoff is very rapid, and erosion is very active. Sediment yield is very high.

This association occupies less than 1 percent of the San Diego Area.

Badland makes up about 65 percent of this association. Acid igneous rock land, Rough broken land, and sand dunes make up the remaining 35 percent.

Badland is of no value for farming or ranching and of very little value for wildlife habitat or watershed.

#### 34. Rock Land Association

## Dominantly exposed bedrock and very large boulders

This association is 50 to 90 percent exposed bedrock and very large boulders. It occurs in the Desert, in the Mountains, and in the Foothills. The outcrops and boulders are chiefly granodiorite, quartz diorite, gabbro, mica schist. metavolcanic rock, and metasedimentary rock. A thin mantle of soil occurs in pockets between the rock outcrops.

This association occupies more than 8 percent of the San Diego Area. Acid igneous rock land makes up 75 percent of the association. Metamorphic rock land and other rocky soils make up the remaining 25 percent

Rock land has no value for farming or ranching. It is used mainly for watershed and wildlife habitat

terraces ranges from nearly sea level to about 800 feet.

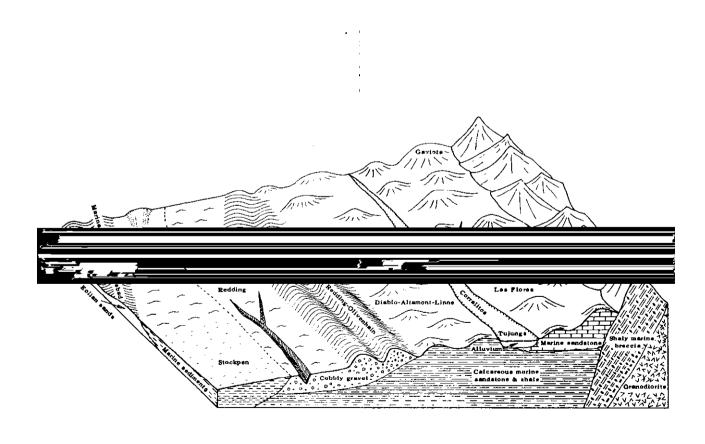
## Formation of the Soils

The parent material from which the soils in the

survey area developed is complex and variable.

The relief differs among the four physiographic provinces—the Coastal Plains, the Foothills, the Mountains. and the Desert.

The climate varies within the Area. The Coastal Plains has an equable climate, but the Mountains and the Desert have wide



Diablo, Linne, and Altamont soils are fine textured to moderately fine textured. Huerhuero, Las Flores, and Stockpen soils have an argillic horizon. Gaviota soils are moderately coarse textured and are underlain by semiconsolidated marine sandstone.

Corralitos, Elder, and Tujunga soils developed in recent sandy alluvium. This material consists of relatively unweathered sediments on flood plains and alluvial fans. It occurs mainly on the Coastal Plains

Salinas soils developed in clayey alluvium derived mainly from Diablo, Linne, Olivenhain, and Huerhuero soils. This alluvium is clay loam to clay in texture. It occurs in narrow drainageways and on alluvial fans on the Coastal Plains.

The San **Onofre breccia** on the Coastal **Plains** is probably of Miocene age. Most **likely** it came about during uplift of the coastal area, or **fluctuations** in sea level, or both. **Hambright** soils were derived from this material.

The vegetation consists of annual grasses, forbs, and brush. Chamise, scrub oak. and sumac are prominent brush species. Wild oats, cheatgrass, and flattop buckwheat are other common plants. There are also scattered oaks and many introduced eucalyptus trees.

Moisture is the main limiting factor. Plant growth is rapid in spring until about June, when the moisture supply is depleted. When the soil is moist, micro-organisms are active and organic matter is oxidized at about the same rate it is added to the soil. The organic-carbon content is about 0.7 percent in the surface layer. It decreases with increasing depth. On shallow, droughty soils there is not enough plant growth to control erosion.

#### Foothills

The Foothills is a belt of narrow winding valleys and rolling to hilly uplands that have few very steep slopes (fig. 6). This belt lies between the Coastal Plains and the Mountains. It is about 28 miles wide and extends in a northwest-southeast direction from Orange and Riverside Counties to the Mexican border. The elevation ranges from about 600 to 2,000 feet. The Foothills and the Coastal Plains are transversed by the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, and Otay Rivers and by numerous small creeks. A, of these streams flow for only a short period after a heavy rainstorm. The adjacent small to large valleys are important farming areas.

The climate in the Foothills is similar to that of the Coastal Plains. The mean annual temperature is 60" F., and the mean minimum temperature in January is 38°. The frost-free season is 220 to 340 days. The winter growing season has only light frost. The amount of rainfall increases with increasing elevation. The total annual rainfall ranges from 12 to 20 inches. Rainfall is heaviest during the period December to April. Most soils are thoroughly moistened during this period, but little leaching occurs. The growing season is short because rapid plant growth in spring uses up soil moisture. Organic matter is oxidized during the long, dry summer; thus, the soils are low in organic-carbon content.

The parent rocks range from granite to gabbro. Most are tonalite and granodiorite and occur as fractured blocks 2 to 10 feet across. The fractures weather out and leave the rest of the block a

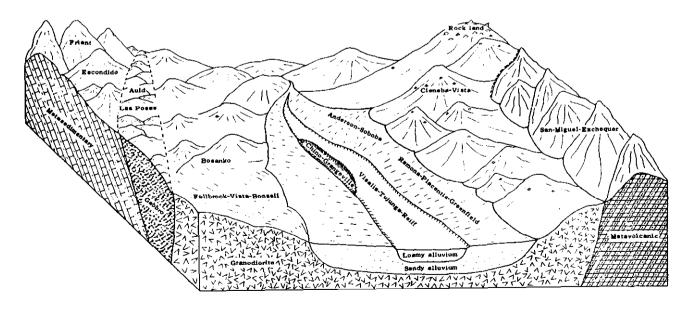


Figure 6.--Typical pattern of soils and underlying material of the Foothills

disintegrated boulder (2). Associated with this bouldery topography are the rocky Cieneba, Fallbrook, and Vista soils. All have large boulders on the surface and within the gruss, which is weathered to a considerable depth.

Parent material weathered from decomposed granite is dominant in the Foothills, the Mountains, and the Desert. This material is soft and is easily eroded. It contains sandfragments, mainly quartz, that act as a" abrasive when carried by runoff. The soils derived from decomposed granite are shallow to deep and are mostly sandy loams. The topography is hilly. Hilltops are rounded or slightly convex, slopes are moderate to very steep, and foot slopes are somewhat concave. Cultivated areas are subject to gully and sheet erosion. The Bonsall, Bosanko, Cieneba, Fallbrook, and Vista soils in the Foothills were derived from decomposed granite.

Gabbro, or basic intrusive rock, occurs as islands in the Foothills and in the Mountains. It has we athered to a considerable depth. The soilsthat developed in this material have a surface layer of fine sandy loam or loam, are shallow to moderately deep, and contain angular, stone size fragments. There are no boulders in these areas, in contrast with the very large, light-colored boulders strewn about in areas underlain by granite. The topography is hilly. Some slopes are steep and have concave foot slopes. Cultivated areas are subject to sheet and gully erosion. The Las Posas and Blasingame soils in the Foothills were derived from gabbro.

Metasedimentary and metavolcanic rocks, which occur mainly in the Foothills, are hard and unweathered. The soils derived from these rocks are moderately deep to very shallow and contain numerous rock

fragments. Auld and San Miguel soils were derived from metavolcanic rock and containmontmorillinitic clay. Escondido, Exchequer, and Friant soils were derived from metasedimentary rock and are fine sandy loam tosiltloam in texture. Exchequer and Friant soils lose soil material through erosion almost as fast as if forms.

The young graniticalluvium in the Foothills was derived predominantly from granitic rock. It is very gravelly sandy loam to fine sandy loam in texture and is fairly we,, sorted. It occurs in broad basins, onalluvial fans. and in "arrow drainage-ways. The Anderson, China. Grangeville, Reiff, and Visalia sails in the Foothills developed in this material.

The old graniticalluvium that has formed in valleys and on terraces and alluvial fans in the Foothills is mainly granitic in origin but has small inclusions of medium-textured sediments of Pleistocene age. Arlington, Greenfield, Placentia, Ramona, and Wyman soils in the Foothills developed in this alluvium. Except for Arlington and Greenfield soils, al, have a strongly developed clayey subsoil.

#### Mountains

Between the Foothills and the Desert are steep-walled, bouldery peaks and broad-based, cone-shaped mountains (fig. 7). The topography is rugged. The elevation ranges mainly from 2,000 to 6,000 feet; some peaks rise above 6,000 feet. The mountain range has a northwest-southeast trend but is broke" by faults and by river valleys. The steep topography, the rockiness, and the shallow soils make

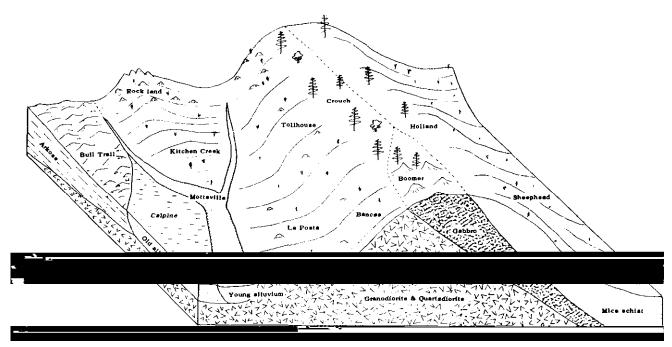


Figure 7.--Typical pattern of soils and underlying material of the Mountains.

the greater part of this area unusable for cultivated crops.

The Mountain area is the coolest, wettest part of the San Diego Area. It receives 12 to 40 inches of precipitation, mainly in winter. The mean annual temperature is 55° F., and the mean minimum temperature in January is 32°. The frost-free season is 150 to 200 days. Snow stays on the ground for only short periods. The soils rarely, if ever, freeze.

Vegetation is more abundant in the Mountainsthan in other parts of the Area. It consists of digger pine, Jeffery pine, white fir, black oak, interior live oak, and incense-cedar. There are also areas of grass and brush. Soils under the pine and oak trees have mats linch to 5 inches thick of fresh and somewhat decomposed needles, leaves, and twigs. The cool climate slows the rate at which microorganisms reduce the supply of organic matter, so these soils typically have the highest organic-carbon content of any soils in the survey area. The organic-carbon content is about 4 percent in the surface layer. It drops to less than 1 percent in the subsoil. Most of the sails are leached of lime and soluble salts.

Granitic rocks, mainly granodiorite and quartz diorite, are dominant in this area (3). Bancas, Crouch, Kitchen Creek, La Posta, and Tollhouse soils developed in material weathered from these rocks. Their texture ranges from loamy coarse sand to stony loam. The rocky Crouch, La Posta, and Tollhouse soils have very large, light-colored granitic boulders on the surface and are shallow to deep over decomposed granite.

Gabbro, or basic intrusive rock, occurs as islands in the Mountains. It has weathered to a considerable depth. The moderately deep to deep Bommer soils were derived from this material. They have a

surface layer of loam and contain many angular, stone-size fragments. There are no boulders.

Micaceous schist, which is strongly metamorphosed, occurs as bands tilted nearly vertically. Holland and Sheephead soils were derived from this material. Both are steep to very steep and have a surface layer of fine sandy loam. Holland soils are deep and have a clay subsoil. Sheephead soils are shallow

Young granitic alluvium was derived predominantly from granitic rocks. It is loamy coarse sand to coarse sandy loam in texture and is fairly well sorted. It occurs on alluvial fans and in narrow drainageways. The Mottsville soils in the Mountains were derived from this material. Calpine soils were derived from slightly older granitic alluvium.

Arkose, which is a form of old granitic alluvium, is sandy loam in texture. It occurs in broad basins in the Mountains. Bull Trail soils were derived from this material.

#### Desert

The Desert, which lies in the rain shadow to the east of the Mountains, is an area of recent, nearly level to moderately sloping alluvial fans and plains (fig. 8). It includes areas of Borrego badlands, lacustrine deposits, and very rocky barren hills.

The Desert receives the least precipitation and has the least vegetation in the entire survey area. There is not enough plant cover to control erosion. Precipitation diminishes rapidly down the abrupt eastern slopes of the Mountains. The amount of rainfall is variable. Total annual rainfall ranges from less than 5 inches to no more than 10 inches; for long periods there may be very little precipitation.

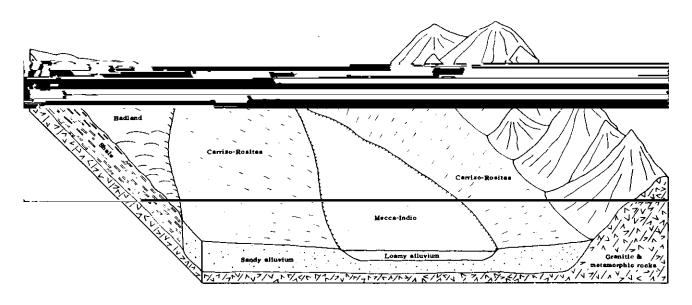
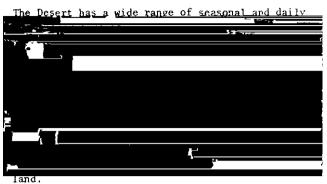


Figure 8.--Typical pattern of soils and underlying material of the Desert



Young granitic alluvium was derived predominantly from granitic rocks. It is very gravelly sand to loamy coarse sand in texture and is fairly well sorted. It occurs in broad basins, on alluvial fans and in narrow drainageways. Some of this material washes down the steep slopes of the Mountains; the rest is from the granitic rock in the Desert. The Carrizo and Rositas soils in the Desert developed in young granitic alluvium.

Recent mixed alluvium was derived from igneous rocks and micaceous schist. It has been deposited on alluvial fans. This material is finer textured than young granitic alluvium and has been deposited more slowly. It ranges in texture from coarse sandy Ioam to silt Ioam. Indio and Mecca soils were de-

rived from recent mixed alluvium.

The shales, sandstones, and conglomerates in the Desert form essentially barren areas that are cut by numerous intermittent drainage channels. These areas are mapped as Badland.

The essentially barren, flat areas of lacustrine deposits are Playas. These deposits are clayey or silty in texture and are typically moderately to strongly saline. Playas form in closed basins in the Desert. Some contain shallow water for a short period after a rain.

TABLE J.-SOIL SERIES CLASSIFIED ACCORDING TO THE CURRENT SYSTEM OF CLASSIFICATION

Series	Family	Subgroup	Order
		_	ļ
Altamont	Fine, montmorillonitic. thermic	Typic Chromoxererts	
	oamy-skeletal, mixed, nonacid, thermic	Typic Xerofluvents	Entisols.
Arlington	Coarse-loamy, mixed, thermic	Haplic Durixeralfs	
Auld	Fine. montmorillonitic, thermic	Typic Chromoxererts	
	Fine-loamy, mixed, mesic	Typic Haploxeralfs	Alfisols.
	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols.
<u>_1</u> / .Bonsall	Fine, montmorillonitic, thermic	Haplic Natrixeralfs	Alfisols.
1/		Traphe Natrixtrairs	711115015.
	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols.
<u>1</u> / Bosanko	Fine, montmorillonitic thermic	Chromix Pelloxererts	Vertisols.
Bull Trail	Fine-loamy, mixed, mesic	Mollic Haploxeralfs	Alfisols.
1/	, inc louny, makea, medie	Wolffe haptoxetures	
	Coarse-loamy, mixed, mesic	Ultic Haploxerolls	Mollisols.
Carlshad	Sandy, mixed, thermic	Haplic Durochrepts	Inceptisols.
Carri 20	Sandy-skeletal mixed, hyperthermic	Typic Torriorthents	Entisols.
	Fine, kaolinitic, thermic	Abruptic Durixeralfs	Alfisols.
Chino-	Fine-loamy, mixed, thermic	Aquic Haploxerolls	Mollisols.
Cieneba	Coarse-loamy, mixed, nonacid, thermic,	Typic Xerorthents	Entisols.
	shallow.	Typic xeroreneses	ALIICISOIS.
Corralitos	Mixed, thermic	Typic Xeropsamments	Entisols.
1/		J F	
Crouch C	oarse-loamy, mixed, mesic	Ultic Haploxerolls	Hollisols.
Diablo~ H	ine, montmorillonitic, thermic	Chromic Pelloxererts	Vertisols.
Elder	Coarse-loamy, mixed, thermic	Fachic Haploxerolls	Mollisols.
Escondido	Coarse-loamy, mixed, thermic	Typic Xerochrepts	Inceptisols.
	oamy, mixed, nonacid, thermic	Lithic Xerorthents	Entisols.
1/			
Fallbrook	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols.
Friant	Loamy, mixed, thermic	Lithic Haploxerolls	Hollisols.
Gaviota	Loamy, mixed, nonacid, thermic	Lithic Xerorthents	Entisols.
Grangeville	Coarse-loamy, mixed, thermic	Aquic Haploxerolls	Mollisols.
Greenfield	Coarse-loamy, mired, thermic	Typic Haploxeralfs	Alfisols.
2/	-		
Hambright	Loamy-skeletal, mixed, thermic	Lithic Haploxerolls	Mollisols.
<u>I/</u> Holland	Fine-loamy, mixed, mesic	Jitic Haploxeralfs	Alficale
Huerbuero	Fine, montmorillonitic, thermic	daplic Natrixeralfs	
India	Coarse-silty, mixed, calcareous, hyper-	Typic Torriorthent	
111010	thermic.	'ypre roll'iorenene	1,1113013,
Indio, dark variant	Coarse-Silty, mixed, thermic	Cumulic Haploxerolls	Mollisols.
Kitchen Crest	Coarse-loamy, mixed, mesic	'ypic Haploxerolls	Miollicolo
	Coarse-toamy, mixed, mesic	ypic napioxerolis	MIOIIISOIS.
<u>1</u> /	Sandy, mixed, mesic	intic Haploxerolls	Miollisols
	Fine, montmorillonitic, thermic	Saplic Natrixeralfs	Alfisols
	Fine, montmorillonitic, thermic	ypic Rhodoxeralfs	Alfisols.
3/	Time, months into interes, chermic	) pre modoxeraris	7.1113013.
Linne	Fine-loamy, mixed, thermic	Calcic Entic	Mollisols.
		Haploxerolls.	
Marina	Mixed, thermic	Ific Xeropsamments	Entisols.
	Coarse-loamy, mixed, calcareous, hyper-	)pic Torriorthents	
	thermic.	'	
Mottsville	Sandy, mixed, mesic	intic Ultic Haploxerolls-	Mollisols.
	Clayey-skeletal, kaolinitic	Itic Palexeralfs	Alfisols
	Fine. montmorillonitic, thermic	Iltic Palexeralfs laplic Natrixeralfs	Alfisols.
	Fine-loamy, mixed, thermic	ypic Haploxeralfs	Alfisols.
ĺ	, ,	,,	
1		I	I

TABLE 3.-SOIL SERIES CLASSIFIED ACCORDING TO THE CURRENT SYSTEM OF CLASSIFICATION--Continued

Series	Family	
1/		
<u>l</u> / Redding	Fine, kaolinitic, thermic	
Reiff	Coarse-loamy, mixed, nonacid, thermic	
Rositas	Mixed, hyperthermic	
Salinas	Fine-loamy, mixed, thermic	
San Miguel	Fine, montmorillonitic, thermic	
Sheephead	Loamy, mixed, mesic, shallow	
Soboba	Sandy-skeletal. mixed, thermic	
Stockpen	Fine, montmorillonitic, thermic	
Tollhouse	Loamy, mixed, mesic, shallow	
Tujunga	Mixed, thermic	
Visalia	Coarse-loamy, mixed, thermic	
1/		
Vista	Coarse-loamy, mixed,	
Wyman		

## INTERPRETATIONS FOR FARMING AND RANCHING

Agriculture is one of the major enterprises in the San Diego Area (5). Truck crops, flowers, and livestock are the major products. Prime soils 5/are required to maintain the agricultural economy at its present level. However, demands for urban or nonfarm use of the soils, rising land values, and increasing taxes make it increasingly difficult for the farmer to stay in business. Intensive farming practices, specialized production, and high capital requirements have changed many agricultural units from the small family-size farm to a factorylike operation. In addition, the rapid expansion of urban development is forcing agriculture into new areas.

In locating new farm sites, farmers are faced with many decisions. The suitability of the soils is the major factor to be considered. Equipped with soil information and proper interpretations, farmers and those who work with farmers can locate and determine what crop is best suited to a particular area. Detailed onsite investigations are needed at specific locations. Also essential in effective long-range planning is locating areas where not only the sails but also the climate and topography are suited to agricultural development.

Information provided by the interpretations in this part of the survey will aid in locating the

best agricultural lands.

The suitability of the soils for five major crops and criteria considered in determining the suitability ratings shown in table 21 are explained in the pages that follow. Also explained are the Storie index ratings, which are shown in the Guide to Mapping Units. In addition, this part of the survey defines the capability classification used by the Soil Conservation Service, in which the soils are grouped according to their suitability for crops. It describes land resource areas and suggests use and management of the soils of the San Diego Area by capability unit. It also describes the management needed for specified craps, shows. estimates of yields of these crops, table 22, and describes range management by range sites.

# Land Resource Areas

Land resource units are broad geographic areas, generally several thousand acres in extent, that are characterized by particular patterns of soil, including slope and erosion, and by climate, water resources, land use, and type of farming (3). The 48 conterminous States in the nation have been divided into 156 land resource areas. The San Diego Area lies within resource areas 19, 20, and 30. Area 19 is on the Coastal Plains and in the Foothills and interior "alleys, area 20 is in the Mountains, and area 30 is in the Desert. These physiographic areas are shown on the general soil map.

Land Resource Area 19.--This area includes the Coastal Plains and the interior "alleys in the Footbills. The dominant topographic features are gently sloping to undulating marine terraces, rolling uplands, smooth to rocky hills, canyons. and relatively narrow, winding "alleys. All rivers and streams flow into the Pacific Ocean. The vegetation consists of coastal chaparral and grasses. Oaks grow in the "alleys. Elevations range from sea levelto 2,000 feet, Rainfall ranges from 10 inches along the coastto 18 inches inland. The only precipitation is gentle rain in winter and early in spring. The frost-free period ranges from 230 to 360 days. Frosts are light and infrequent.

The major limiting factors are steep slopes, shallow soils, claypans, stones, and rock outcrops.

In establishing the capability classification for land resource area 19, it is assumed that--

Irrigation water is available for all irrigable soils. In some places the water supply is salty enough so that drainage and leaching are required for crops that are highly sensitive to salts. Rainfall is adequate for leaching so that most craps are not damaged by accumulation of salts.

The major crops are grown commercially. Frosttolerant flowers and truck crops are grown in winter; frost-sensitive perennial crops, citrus, and avocados are grown in locations that

have goad air drainage.

Land Resource Area 20,--This area is the Southern California Mountains, known as the peninsular range. The topography is dominantly steep and very steep, but there are small drainage meadows and narrow and broad mountain "alleys. Most of the very steep slopes are on the sides of young, V-shaped river "alleys. The vegetation consists of chaparral, trees, and grasses. Elevations range from 2,000 to about 6,000 feet. The precipitation is more than 20 inches; at the highest elevations it is more than 40 inches. Rain falls mostly in winter and spring; summer thunderstorms occur infrequently at higher elevations. The frost-free period ranges from 140 to 260 days.

The major limiting factors are steep slopes. shallow soils, low temperatures, stones, and cobblestones.

In establishing the capability classification for land resource area 20, it is assumed that--

Irrigation water generally is not available; the water supply within this area is limited. Some water is used locally for irrigating orchards, The principal source of moisture for crops is rainfall and snowfall in winter and early in spring.

Pears and apples are the major crops. Most of the acreage is rangeland and woodland.

<u>Land Resource Area 30.--This</u> area is the Sonoran Basin and Range. It includes most of the eastern and northeastern third of the San Diego Area. It

Prime soils, as defined in the Land Conservation Act of 1965 of the California State Legislature, are soils that are in capability classes I and II or produce \$200 or more gross annual income 3 years out of 5.

extends from Riverside County to the Mexican border. It is characterized by many short ranges of nearly barren mountains, some older alluvial deposits or terrace remnants, and extensive recent alluvial fans and desert basins, some of which are saline or saline-alkali. Elevations range from 100 to 2,500 feet. The mean annual precipitation is less than 5 inches. Much of the precipitation falls during high intensity storms, which at times produce local floods and little soil moisture. The climate is extremely arid. The vegetation is sparse desert shrubs and cactus. Some areas have a fair cover of mesquite and creosotebush. Temperatures are high in summer, and there is a wide fluctuation between the maximum and the minimum temperatures.

The major limiting factors are lack of irrigation water, stones, cobblestones, low available water holding capacity, low fertility, and the hazard of

wind erosion.

I' establishing the capability classification in land resource area 30, it is assumed that-

Because of inadequate rainfall, the soils are not suitable for cultivation unless irrigated In most of the area, rainfall is inadequate for a sustained yield of any native forage. The frost-free season is 210 to 260 days. Potential evapotranspiration is 40 inches or more, and the actual evapotranspiration is less than 5 inches.

Irrigation water is scarce; it is mainly from wells. The Borrego Valley is the only are a that has a" adequate supply of good-quality irrigation water. Only a few small tracts elsewhere in the resource area are irrigated. Water quality varies in amount and composition of soluble salts. In places the salt\* content is so high that leaching is required. Wind erosion is a continuing problem in some

however, measures are needed for reducing the flood hazard.

The choice of crops is somewhat limited because of the climate. Forage crops are the principal crops, but citrus, grapes, cotton, and vegetables are grown also.

#### Crop Suitability

The western third of the San Diego Area, that is, the Coastal Plains and the Foothills, Land Resource Area 19, is climatically adapted to year-round agricultural production. Elevations are near sea level to about 2,000 feet. Avocados, citrus, truck crops, tomatoes, and flowers are the major crops.

Except for the alluvial plains, the soils on Camp Pendleton are too steep and shallow for agriculture. North and south of San Marcos and scutheast of Lemon Grove extending to the Mexican border are areas of steep soils that are shallow overimpervious metamorphic rock. None of these areas are used for agriculture. Near Miramar the soils are low in fertility and have too many cobblestones to be suitable for cultivation. Areas in the Mountains lack irrigation water, and winters are too cool for extensive cropping. Areas in the Desert also lack irrigation

General requirements for each crop listed in table 21 are given

TABLE 23. -- CRITERIA FOR RATING SOILS FOR GROWING AVOCADOS

No rating	Fair	Good
Less than 36 inches	36 to 60 inches	More than 60 inches.
		alluvium.

# S66 Calif.-37-1

Classification: Typic Durixeralf fine-loamy, mixed, thermic

- 1. Major Diagnostic Horizons
  - 1.1 Ochric epipedon O-15"
    - 1.11 Chroma 4 moist
    - 1.12 **Value** 4 moist O-2"
      - 3 moist 2-15"
    - 1.13 0.C. 0.9-2% A horizon
  - 1.2 Argillic Two possibilities 1) 2-22" or 2) 33-35" depending on how clay content 1.21 No lab. data on B2t 33-35" Assume that clay content is more is plotted. than 25.5%
    - 1.22 Field textures

Lab. textures

All O-2 loam

loam (near sandy loam)

AL2 2-15 loam

loam

Bl 15-33 clay loam

loam

B2t 33-35 heavy clay loam

- 1.23 gradual A/BI bdy clear B1/B2t bdy
- 1.24 BS Assume Less than 75% by sum
- 1.3 Duripan
  - 1.31 Depth to pan 35"
  - 1.32 Massive and indurated
- 2. Other Diagnostic Features
  - 2.1 Xeric moisture possibly aridic
  - 2.2 Thermic soil temperature
  - 2.3 fine-loamy control section
- 3. Remarks

There is a possibility that this pedon does not have an argillic horizon.

- 3.1 The required clay increase is met from the All (15%) to the Al2 (18.3%) but no illuviation is described.
- 3.2 The clay increase may be met at 35 inches but the B2t 33-35 is only 2 inches thick; must be at least 3 inches (7.5cm) thick.
- 3.3 From the All to the B1 there is enough clay increase but it is reached in 13", criteria is 12".
- 3.4 By plotting the clay curve and assuming 25% in the B2t hor. the % of clay at 20" would be 20% and would increase within 12" (20 to 32") to greater than 24% therefore qualifying as an argillic.

#### NOTES ON SOIL CLASSIFICATION

## S66 Calif.-37-2

Classification: Abruptic Durixeralf fine, mixed, thermic

- 1. Major Diagnostic Horizons
  - 1.1 Ochric epipedon O-15"
    - 1.12 Value and chroma 4/6 & 5/4 moist
  - 1.2 Argillic
    - 1.21 Clay increase 26.1% absolute A to B1
    - 1.22 Bl hor. should be Blt

1.23 <u>Field textures</u>	Lab. textures
Al O-4 loam	sandy loam
A2 4-15 loam	<pre>sandy loam (near loam)</pre>
<b>Bl</b> 15-18 clay	clay loam
B2t 18-30 clay	clay
201 durainan	

- 30+ duripan ..24 Abruptic criteria
  - 1.241 greater than 35% clay in all parts (37.4% or 60.2% 1.242 greater than 15% clay increase in clay within 2.5cm
    - 37.4 to 60.2%, very abrupt bdy (B1 15-18"to B2t 18-30")
- 1.3 Duripan at 30"
  - 1.31 Massive and/or indurated pan
- 2. Other Diagnostic Features
  - 2.1 Xericpossibly aridic
  - 2.2 Thermic
  - 2.3 Mineralogy appears to be mixed with high amounts of kaolinite
  - 2.4 Albic horizon 4-15"
- 3. Remarks
  - 3.1 This pedon appears to have an increase in clay above the "claypan" that would qualify as an argillic horizon

### NOTES ON SOIL CLASSIFICATION

# S66 Calif.-37-3

Classification: Typic (Entic) Durochrept coarse-loamy, mixed, thermic, shallow

- 1. Major Diagnostic Horizons
  - 1.1 Ochric epipedon O-10" 1.11 Color moist 4/6, 5/4 1.12 O.C. 5% O-1" 1% 1-5"
  - 1.2 Duripan at 11" B2t sim
    - 1.21 Does this horizon slake in water?
    - 1.22 11-21" May not be massive and indurated or platy
    - 1.23 The B2t sim should only have the si suffix
- 2. Other Diagnostic Features
  - 2.1 Duripan at depths less than  $20^{11}$  shallow family
  - 2.2 coarse-loamy
  - 2.3 B.S. 42%, 88%, 75% O-10" (NH4OAc)
  - 2.4 <u>Field textures</u>
    All O-1 loam
    Al2 l-5 loam
    A2 5-10 loam

Lab.textures
loam (near sandy loam)

sandy loam
loam (near sandy loam)

- 2.5 Xeric possibly aridic
- 2.6 Thermic

## NOTES ON SOIL CLASSIFICATION

# S66 Calif.-37-4

Classification: Natric (Ultic) Haploxeralfs fine-loamy, mixed, thermic

1. Major Diagnostic Horizons
1.1 Ochric epipedon 0-10"
1.11 Color moist 4/3, 5/3
1.12 O.C. 0-4" 2.0% 4-10" 0.3%
1.2

- 2. Other
  - 2.1
  - 2.2
  - 2.3
  - 2.4

# S66 Calif.-37-5

Classification: Natric (Ultic) Haploxeralfs fine, mixed, thermic

- 1. Major Diagnostic Horizons
  - 1.1 Ochric epipedon O-14"
    - 1.11 Color 3-14 6/3 dry 4/3 moist
    - 1.12 Thickness for mollic epipedon would have to be at least  $10^{\prime\prime}$ .
  - 1.2 Argillic horizon 24-92" or 35-92"
    - 1.21 Bl horizon should be a Blt horizon
    - 1.22 B21t 35 to 45" weak prismatic structure if ESP 15 or in sqme subhorizon would be a Natric horizon
    - 1.23 If argillic started at 24" weighted ave. would be 38% clay (B1(t) and B21t (24-44") assuming 30% clay in the B1 horizon 24-35"
    - 1.24 B.S. Assume less than 75% in all parts of <a href="mailto:argillic">argillic</a> (sum)
- 2. Other Diagnostic Features
  - 2.1 Xeric possibly aridic
  - 2.2 Thermic
- 3. Remarks
  - 3.1 Two possible classifications depending on assumptions because of lack of data
    - 3.11 with Natric horizons Typic (Ultic) Natrixeralfs fine,
       mixed, thermic
    - 3.12 without Natric horizons Natric (Ultic) Haploxeralfs fine, mixed, thermic There is no subgroup provided for both natric and ultic.

